ORNL/TM 2013/565

OAK RIDGE NATIONAL LABORATORY

Site Sustainability Plan

with FY 2013 Performance Data

December 2013

U.S. DEPARTMENT OF ENERGY

OAK RIDGE National Laboratory

DOCUMENT AVAILABILITY

Reports produced after January 1, 1996, are generally available free via the U.S. Department of Energy (DOE) Information Bridge.

Web site http://www.osti.gov/bridge

Reports produced before January 1, 1996, may be purchased by members of the public from the following source.

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone 703-605-6000 (1-800-553-6847)
TDD 703-487-4639
Fax 703-605-6900
E-mail info@ntis.gov
Web site http://www.ntis.gov/support/ordernowabout.htm

Reports are available to DOE employees, DOE contractors, Energy Technology Data Exchange (ETDE) representatives, and International Nuclear Information System (INIS) representatives from the following source.

Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831
Telephone 865-576-8401
Fax 865-576-5728
E-mail reports@osti.gov
Web site http://www.osti.gov/contact.html

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ORNL/TM-2013/565

Energy and Transportation Science Division

Site Sustainability Plan with FY 2013 Performance Data

December 2013

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

BIO
OAK RIDGE
National Laboratory
ECO

Contents

Figure and table lists ii

Acronym list iii

Section I. Executive Summary iv

Section II. Performance Review and Plan Narrative

Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory 1
- 1.1 GHG Reduction—Scopes 1 and 2 1
- 1.2 GHG Reduction—Scope 3 4

Goal 2: Buildings, Energy Savings Performance Contract Initiative, and Regional and Local Planning 7
- 2.1 Energy Intensity Reductions 7
- 2.2 Energy Independence and Security Act Section 432 Energy and Water Evaluations 8
- 2.3 Individual Buildings Metering 9
- 2.4 Cool Roofs 10
- 2.5 High Performance Sustainable Buildings—Existing Buildings 10
- 2.6 High Performance Sustainable Buildings—New Construction 12
- 2.8 Regional and Local Planning 12

Goal 3: Fleet Management 14
- 3.1 Fleet Alternative Fuel Consumption 14
- 3.2 Reductions in Fleet Petroleum Consumption 15
- 3.3 Purchase of Alternative Fuel Vehicles for Light-Duty Vehicles 15
- 3.4 Fleet Inventory—Rightsizing the Fleet 16

Goal 4: Water Use Efficiency and Management 16
- 4.1 Potable Water 16
- 4.2 ILA Water Consumption 18

Goal 5: Pollution Prevention and Waste Reduction 18
- 5.1 Solid Waste Reductions (nonhazardous, other than construction waste) 18
- 5.2 Construction and Demolition Materials and Debris 19
- 5.3 Additional Qualitative Components within Goal 5 20

Goal 6: Sustainable Acquisition 21
- 6.1 Sustainable Acquisitions and Procurements 21

Goal 7: Electronic Stewardship and Data Centers 21
- 7.1 Meters for the Measurement of Power Utilization Effectiveness (PUE) 21
- 7.2 Annual Weighted Power Utilization Effectiveness Goals 22
- 7.3 Electronic Stewardship 23

Goal 8: Renewable Energy 25
- 8.1 Renewable Energy Performance 25

Goal 9: Climate Change Adaptation 25

Section III. New Fleet Management

Oak Ridge National Laboratory Right-Sizing of Fleet Management Plan 27

Section IV. Site Innovation 27

Section V. Management and Funding 30

Section VI. Electrical Energy Projections and High Energy Mission Specific Facilities 35

Section VII. Utility Usage, Costs, and Projections 38

Appendixes

Appendix A: ORNL Self-Certification Form Listing the Excluded Buildings for the Energy Intensity Goal 41

Appendix B: Oak Ridge National Laboratory Right-Sizing of Fleet Management Plan 45

Appendix C: ORNL Consolidated Energy Data Report Submission 50

Figure and table lists

Figures

Figure 1. ORNL Scopes 1 and 2 greenhouse gas (GHG) emissions performance status for FY 2013 compared with FY 2008. 2
Figure 2. ORNL greenhouse gas (GHG) reduction plan by source (2020 goal = 244,085 $MTCO_2e$). 3
Figure 3. ORNL Scope 3 GHG emissions for FY 2013 compared with the FY 2008 baseline. 5
Figure 4. ORNL greenhouse gas Scope 3 snapshot. 7
Figure 5. Summary of energy intensity results and progress toward goal. 7
Figure 6. ORNL building energy performance for the last decade. 7
Figure 7. Energy use intensity improvement: 2003 vs 2015. 8
Figure 8. ORNL plan for high performance sustainable buildings (2015 goal = 22 HPSBs). 11
Figure 9. E85 fuel use in flexible fuel vehicles for FY 2013. 14
Figure 10. ORNL water use intensity (WUI) FY 2007–FY 2020, including 2020 and incremental DOE goals. 17
Figure 11. Water use intensity (WUI) reduction plan. 17
Figure 12. ORNL municipal waste diversion. 19
Figure 13. ORNL construction and demolition waste diversion. 19
Figure 14. ORNL electronic stewardship and electricity savings. 24
Figure 15. ORNL's high energy mission specific facilities. 35
Figure 16. Utility services at ORNL (consumption in natural units). 38
Figure 17. FY 2013 utility energy consumption and percentages. 38
Figure 18. ORNL utility costs for FY 2013. 39
Figure 19. Projected ORNL electrical energy costs. 39

Tables

Table 1. Summary of ORNL attainment of DOE sustainability goals v
Table 2. Scope 1 and Scope 2 GHG performance data (FY 2013 compared with the FY 2008 baseline). 2
Table 3. ORNL Scope 1 GHG emission projections to 2020 (target year). 3
Table 4. ORNL electricity projections and Scope 2 GHG emission projections without renewable energy credit purchases 4
Table 5. ORNL Scope 3 GHG emissions performance status 4
Table 6. ORNL energy audit results in annual square footage and percentage of campus 9
Table 7. Actual and projected water use intensity estimates by year 17
Table 8. Potential savings identified by project 23
Table 9. ECM projects, budget, and schedule. 32
Table 10. ECM actual and planned overhead expenses 34

Acronym list

AFV	alternative fuel vehicle
ALARA	as low as reasonably achievable
ARES	Advanced Reciprocating Engine Systems (DOE program)
ARRA	American Recovery and Reinvestment Act
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
AWA	Alternative Workplace Agreements
AWH	alternate work hour
B20	fuel blend consisting of 20% biodiesel and 80% petrodiesel
BAS	Building Automation System
BOA	blanket ordering agreement
BSP	Biomass Steam Plant
Btu	British thermal unit
CACS	cold aisle containment system
C&D	construction and demolition
CCSI	Climate Change Science Institute
CEDR	Consolidated Energy Data Report
CEDS	Central Energy Data System (ORNL)
CNMS	Center for Nanophase Materials Sciences
CPU	central processing unit
CSB	Computational Science Building
CSBX	Computational Science Building Annex
CRU	computer room unit
DOE	US Department of Energy
E85	fuel blend consisting of up to 85% ethanol with up to 15% gasoline (also, E-85)
EC	energy consuming
ECM	energy conservation measure
EO	Executive Order
EPA	US Environmental Protection Agency
EPACT	Energy Policy Act
ESCO	energy service company
ESPC	energy savings performance contract
EUI	energy use intensity
EV	electric vehicle
F&O	Facilities and Operations Directorate
FAR	Federal Acquisition Regulations
FAST	Federal Automotive Statistical Tool
FFV	flexible fuel vehicle
FIMS	Facilities Information Management System
G/GSF	gallons per gross square foot
GGE	gasoline gallon equivalent
GHG	greenhouse gas
GI/LID	green infrastructure and low-impact development
GP	guiding principle
GPY	gallons per year
GSA	General Services Administration
GSF	gross square feet/gross square footage
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, ventilation, and air conditioning
ILA	industrial, landscaping, and agricultural
IPM	integrated pest management
IRSC	Indian River State College
IT	information technology
ITSD	Information Technology Services Division
JCI	Johnson Controls, Inc.
JIT	just-in-time
kW	kilowatt
kWh	kilowatt-hour
LEED	Leadership in Energy and Environmental Design
LEED AP	Leadership in Energy and Environmental Design Accredited Professional
LSS	Laboratory Shift Superintendent
LSV	low-speed vehicle
MGY	million gallons per year
MHP	Managed Hardware Program
MMBtu	million British thermal units
MRF	Multiprogram Research Facility
MSW	municipal solid waste
$MTCO_2e$	metric tons of carbon dioxide equivalent
MVSP	Melton Valley Steam Plant
MW	megawatt
MWh	megawatt-hour
NEPA	National Environmental Policy Act
OLCF	Oak Ridge Leadership Computing Facility
OMB	Office of Management and Budget
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Office
ORR	Oak Ridge Reservation
OSO	Oak Ridge Site Office (DOE)
OTC	once-through cooling
P-Card	purchasing card
P2	pollution prevention
PEV	plug-in EV
PlanET	Plan East Tennessee
PPA	power purchase agreement
PUE	power utilization effectiveness
PV	photovoltaic
R&D	research and development
RE	renewable energy
REC	renewable energy credit (also, renewable energy certificate)
REDC	Radiochemical Engineering Development Center
SAMAB	Southern Appalachian Man and the Biosphere
SCI	Sustainable Campus Initiative
SF_6	sulfur hexafluoride
SME	subject matter expert
SMR	small modular reactor
SNS	Spallation Neutron Source
SSG	Southeast Sustainability Group
SSP	site sustainability plan
SSPP	strategic sustainability performance plan
SUV	sport utility vehicle
T&D	transmission and distribution
TVA	Tennessee Valley Authority
UPS	uninterruptible power supply
VAC	volts alternating current
VAV	variable air volume
VFD	variable frequency drive
WPT	Wireless power transfer
WUI	water use intensity

Executive Summary

Oak Ridge National Laboratory (ORNL) is both the largest science and energy laboratory of the US Department of Energy (DOE) and one of the oldest national laboratories still operating at its original site. These characteristics provide the Sustainable Campus Initiative (SCI) both a unique opportunity and a unique challenge to integrate sustainability into facilities and activities. As outlined in this report, SCI is leveraging the outcomes of ORNL's DOE-sponsored research and development programs to maximize the efficient use of energy and natural resources across ORNL. Wherever possible, ORNL is integrating technical innovations into new and existing facilities, systems, and processes with a widespread approach to achieving Executive Order 13514. ORNL continues to pursue and deploy innovative solutions and initiatives to advance regional, national, and worldwide sustainability and continues to transform its culture and engage employees in supporting sustainability at work, at home, and in the community. Table 1 summarizes ORNL's FY 2013 performance and planned actions to attain future goals. ORNL has achieved numerous successes during FY 2013, which are described in detail throughout this document. Some key highlights are listed below.

High Performance Sustainable Buildings (HPSBs): ORNL's DOE target is to complete 22 HPSBs by FY 2015. Twenty-three HPSBs were completed in FY 2013, exceeding the DOE target and doing so 2 years ahead of schedule.

Fleet Management: ORNL achieved a 53% reduction in petroleum consumption compared with the 2005 baseline. Additionally, 100% of light duty vehicles purchased in FY 2013 were alternative fuel vehicles. These include two fuel-efficient diesel-hybrid buses obtained through a transaction with Idaho National Laboratory, which resulted in $300,000 in savings to local taxpayers. ORNL also maintained a 68% average of E85 usage in FY 2013.

Water Management: FY 2013 water use intensity measured an 18% reduction to date; the FY 2013 target was 12%.

ORNL received a 2013 Federal Energy and Water Management Award for the water resource, energy, and fleet Management Programs.

Energy Use Intensity (EUI): ORNL achieved an EUI reduction of 46.5%, well ahead of the DOE goal of a 30% reduction by FY 2015 compared with a FY 2003 baseline.

Biomass Steam Plant: During the first full year in operation, the Biomass Steam Plant has already contributed to a natural gas reduction of 44% in the production of steam compared with usage prior to implementation.

ORNL received a Tennessee Chamber of Commerce and Industry Outstanding Achievement Award for Air Quality.

Sustainable Acquisition: Effective October 1, 2012, all new subcontracts are electronically maintained. This is three years ahead of the ORNL Sustainability target date and represents annual cost savings of over $222,000.

Community Engagement: The third Annual Sustainability Summit was held in Knoxville, Tennessee, with close to 300 in attendance. Southeast Sustainability Group (SSG), a new nonprofit sustainability organization, was introduced. SSG comprises ORNL and other research, academic, and industry partners throughout eight southeastern states.

ORNL was awarded a 2013 GreenGov Presidential Award in the "Good Neighbor" category in November 2013.

Sustainable Transportation: As a result of continuous promotion of participation in Smart Trips, ORNL experienced a 21% increase in registrants this year, with a total of 101 employees logging 17,655 commute alternative entries.

ORNL received the 2013 Smart Trip Commuter Challenge Award (Winner Heavy Weight category and second place Overall Commuter Challenge).

Peer to Peer Network: ORNL is one of six laboratories invited by the DOE Sustainability Performance Office to serve as a sustainability subject matter expert with the goal of helping DOE achieve its federal sustainability goals more efficiently by leveraging the knowledge, expertise, and resources of the collective group.

Table 1. Summary of ORNL attainment of DOE sustainability goals

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions	Risk of Nonattainment
Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory				
1.1	28% Scope 1 & 2 greenhouse gas (GHG) reduction by FY 2020 from a FY 2008 baseline (2013 target: 17% reduction)	**Scope 1** estimate is 43,895 $MTCO_2e$, a decrease of 51% from FY 2008. **Scope 2** estimate is 307,660 $MTCO_2e$, an increase of 23% from FY 2008 after allowances for purchased renewable energy credits (RECs). **Scope 1 & 2** combined estimate is 351,555 $MTCO_2e$, an increase of 4% from the baseline year of 2008.	**Scope 1** reductions are on target due to energy conservation measures and the results from the ESPC implementation, including the Biomass Steam Plant. **Scope 2** reductions present more of a challenge due to growth in electricity demands for high energy mission specific facilities.	**Scope 1: Low** **Scope 2: High**
1.2	13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline (2013 target: 4% reduction).	**Scope 3** estimate is 42,559 $MTCO_2e$. Overall Scope 3 emissions have increased by 4%. While all other elements are on trend to meet target goals, a 23% increase in transmission and distribution (T&D) losses limits the overall performance.	Employee engagement focus areas such as responsible business travel, employee commute, and telework programs will ensure progress toward Scope 3 reductions. T&D losses will grow along with purchased electricity; however, a new substation coming online in FY 2015 will reduce ORNL's T&D losses by about 3% (~0.75 MW) and thus reduce power purchases and companion Scope 3 GHG emissions.	**High**
Goal 2: Buildings, Energy Savings Performance Contract Initiative Schedule, and Regional & Local Planning				
2.1	30% energy intensity (Btu/GSF) reduction 30% by FY 2015 from a FY 2003 baseline (2013 target: 24%).	ORNL achieved a reduction of 46.5% and is currently on track to exceed the FY 2015 goal. Natural gas was replaced by biomass.	Ongoing energy audits in progress will identify energy conservation projects to maintain the 30% goal.	**Low**
2.2	Each year evaluate a minimum of 25% of 75% of facility energy use over a 4-year cycle per Energy Independence and Security Act Section 432.	Over 25% evaluated during this first year of a second four-year cycle.	Continue pace of 25% or more through current cycle (end of FY 2016). Leverage knowledge from prior cycles to conduct focused evaluations	**Low**

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions	Risk of Nonattainment
2.3	Individual buildings metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015) (2013 target: 40%). Data Centers to be metered at 100% by FY15 (2013 target: 70%).	ORNL is in compliance with DOE mandates by achieving 90.3% for electrical use, surpassing the goal. Data centers are 100% metered. The remaining systems are progressing toward full compliance.	Continued implementation of metering plan will allow progress toward metering of all commodities. Goals have been met in respect to natural gas, chilled water, potable water, steam, and data center requirements.	**Low**
2.4	Cool roofs – all new roofs and roof replacements must meet Cool Roof standards and have thermal resistance of at least R-30 (unless uneconomical or excluded).	ORNL completed approximately 13,105 ft^2 in new cool roofs.	All new construction and renovated facilities will employ cool roof technologies.	**Low**
2.5	15% of existing buildings greater than 5,000 GSF are compliant with the guiding principles (GPs) for high performance sustainable buildings (HPSBs) by FY 2015 (2013 target: 11%).	Six additional existing buildings achieved HPSB status for a total of 23, exceeding the goal of 15% (22 buildings) by FY 2015—2 years ahead of schedule.	Efforts will continue toward expanding the existing HPSB inventory—planning for two additional buildings in FY 2014.	**Low**
2.6	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs.	To date, 16 new facilities have been LEED certified. 6 are LEED Gold, 2 more are pending LEED Gold. 2 buildings are LEED Silver.	*All* new construction is specified for LEED Gold as a routine part of the facility development process. Two planned facilities are expected to be in design phase in FY 2014.	**Medium**
Goal 3: Fleet Management				
3.1	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline (2013 target: 114% cumulative since 2005).	To date alternative fuel usage is 68% of total fuel consumed.	Continue to use alternative fuels, and continue to educate drivers about the importance of using alternative fuels in flexible fuel vehicles (FFVs). Work to ensure availability of alternative fuels.	**Medium**
3.2	2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline (2013 target: 16% cumulative since 2005).	ORNL achieved a 53% reduction in fleet petroleum consumption compared to the 2005 baseline.	Continue to use alternative fuel. Continue to ensure availability of biodiesel fuel. There is a history of limited supplies.	**Medium**

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions	Risk of Nonattainment
3.3	75% of light-duty vehicle purchases must consist of alternative fuel vehicles (AFVs) by FY 2000 and thereafter.	100% of the light duty vehicles purchased in FY 2013 were AFVs.	Continue to purchase AFVs from General Services Administration (GSA) schedules as funds and approvals are available.	**Low**
3.4	Reduce fleet inventory of non-mission-critical vehicles by 35% by FY 2013 relative to a FY 2005 baseline.	ORNL "Right-Sizing of Fleet Management Plan" dated December 2012 is included as Appendix B.	Not applicable	Not applicable
Goal 4: Water Use Efficiency and Management				
4.1	26% potable water intensity (G/GSF) reduction by FY 2020 from a FY 2007 baseline (FY 2013 target: 12%).	Water use intensity measured 145 G/GSF (a reduction of 18% to date).	Additional savings are planned that include eliminating additional once-through cooling and repair of leaks in the water distribution system.	**Low**
4.2	20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2020 from a FY 2010 baseline.	Not applicable. No ILA water is used at ORNL.	Not applicable.	Not applicable.
Goal 5: Pollution Prevention and Waste Reduction				
5.1	Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris, by FY 2015.	A 34% diversion rate was achieved in FY 2013. While less than the target, this represents a significant improvement in the past year.	Continue mediation measures and process improvement in FY 2014 and beyond to assure attainment.	**Medium**
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015.	ORNL's diversion rate for construction and demolition debris for FY 2013 is 39%.	Continue process improvements to meet or exceed the goal by FY 2015. Additional focus will be place on segregation of waste.	**Medium**
Goal 6: Sustainable Acquisition				
6.1	Procurements meet requirements by including necessary provisions and clauses (Sustainable Procurements / Biobased Procurements).	100% of all procurement transactions in FY 2013 (excluding purchase card transactions) contained terms and conditions that invoke requirements for sustainable acquisitions.	Procurements transactions will continue to include standard UT-Battelle terms containing sustainable acquisition requirements.	**Low**
Goal 7: Electronic Stewardship and Data Centers				
7.1	All data centers are metered to measure monthly power utilization effectiveness (PUE) of 100% by FY 2015 (2013 target: 80%).	All existing data center equipment is metered.	Plans are being developed for adding meters in the 5800 Chiller Plant.	**Low**

SC/SSPP/ OMB Goal	DOE Goal	Performance Status through FY 2013	Planned Actions and Contributions	Risk of Nonattainment
7.2	Maximum annual weighted average PUE of 1.4 by FY 2015 (2013 target: 1.60).	The calculated PUE value at the end of FY 2013 is calculated as 1.29 for the MRF data center and 1.26 for the CSB data center.	Automated real-time PUE calculation for all data centers to be in place in FY 2014. Ability to provide monthly and annual PUE calculations will continue to progress toward the FY 2015 goals.	**Low**
7.3	Electronic Stewardship – 100% of eligible equipment with power management implemented and in use by FY 2012.	100% of the eligible PCs, laptops, and monitors are being actively power-managed.	Continue to actively ensure all eligible computing equipment is power managed.	**Low**
Goal 8: Renewable Energy				
8.1	20% of annual electricity consumption from renewable sources by FY 2020 (2013 target: 7.5%).	ORNL produced on-site renewable electricity of less than 0.024% of consumption and purchased a small amount of green power from TVA. In addition, a number of local (TVA) and marketplace REC purchases resulted in a total of 57,558 MWh of renewable attributes, exceeding the 7.5% FY 2013 goal at 10.02%.	Annual REC purchases will permit ORNL to meet the goal until additional cost-effective on-site generation is implemented.	**Medium**

II Performance Review and Plan Narrative

Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory

1.1 GHG Reduction—Scopes 1 and 2

DOE Goal: 28% reduction in Scopes 1 and 2 GHG emissions by FY 2020 from a FY 2008 baseline (2013 target: 17% reduction).

Oak Ridge National Laboratory's (ORNL's) Sustainable Campus Initiative (SCI) continues its drive to integrate the sustainability message into organizational processes and procedures. Personnel have become more aware of how daily 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, process improvement plans currently being developed in a number of divisions will work in concert to promote sustainability and reduce greenhouse gas (GHG) emissions by source (covering all scopes), resulting in improved operational efficiencies.

As is the case with most organizations, ORNL's greatest source of GHG emissions is a result of purchased electricity, the primary contributor of Scope 2 emissions—something over which we have little control. One of our most proactive activities in this area (detailed under Site Innovations Section) is working with the Tennessee Valley Authority (TVA), our regional electrical power provider, to reduce carbon emissions whenever possible.

1.1.1 Performance Status

ORNL aggressively strives to have a positive influence on achieving the overall DOE goal of a 28% reduction target for total Scope 1 and Scope 2 GHG emissions. The FY 2013 Scopes 1 and 2 GHG emissions inventory is reported in Table 2 and the following is a summary of these results.

- The FY 2013 Scope 1 GHG estimate is 43,895 $MTCO_2e$, a decrease of 51% from the FY 2008 baseline. Scope 1 reductions are on target due to previously implemented energy conservation measures (ECMs) and the results from the Johnson Controls, Inc. (JCI), energy savings performance contract (ESPC) implementation. The Biomass Steam Plant (BSP) was a major ECM for this ESPC project and reached operational status in July 2012. FY 2013, the first full year of operations, saw a 44% decrease in natural gas purchases for facility operations compared to the FY 2008 baseline. This showcase facility is the primary reason for the reduction in natural gas consumption at the site in FY 2013 and will drive further reductions in the future.
- As shown in Table 2, Scope 2 GHG emissions totaled 356,508 $MTCO_2e$ before renewable energy credits (RECs). Purchased RECs from wind power projects resulted in the avoidance of 48,848 $MTCO_2e$ in GHG emissions, reducing the FY 2013 Scope 2 GHG estimate to 307,660 $MTCO_2e$, an increase of 23% over FY 2008. This increase in Scope 2 emissions is the result of growth in purchased electricity.
- The combined total for FY 2013 Scope 1 and 2 estimates is 351,555 $MTCO_2e$, an overall increase of 4% from FY 2008.
- SF_6 process losses decreased greatly in FY 2013 as plans for the decommissioning of the Holifield Radioactive Ion Beam Facility (HRIBF) continued to develop. (See SF_6 progress.)
- Purchased electricity continues to grow as important mission facilities such as the ORNL world-class computer facilities continue to expand. (See Figure 1.)

SF_6 Progress

The Physics Division's 25-million-volt tandem electrostatic accelerator houses the largest inventory of sulfur hexafluoride (SF_6) gas at ORNL. This accelerator was one component of HRIBF, which was operated as a nuclear physics facility for research with radioactive ion beams from 1996 to 2012. Limited, stand-alone operation of the tandem accelerator continues. The SF_6 insulating gas is required for safe operation of the accelerator to prevent electrical discharge from the high-voltage terminal and accelerating column.

The tandem accelerator uses an SF_6 capture system that was part of its original design. When the SF_6 is in gaseous phase during accelerator operation, it is recirculated through the accelerator pressure vessel. When maintenance inside the accelerator pressure vessel is required, the SF_6 is compressed to the liquid phase and transferred to three storage (capture) pressure vessels in Building 6005. Following maintenance activities, the gas is vaporized and returned to the accelerator pressure vessel. Thus the system continuously captures and reuses the inventory of SF_6. SF_6 is a key contributor to the ORNL Scope 1 GHG emissions inventory. It will be mandatory to actively manage SF_6 emissions to meet the DOE overall reduction goal of 28% for Scope 1. Awareness of the global warming potential of SF_6 has resulted in a more cautious approach to the requisition

Table 2. Scope 1 and Scope 2 GHG performance data (FY 2013 compared with the FY 2008 baseline)

Scope 1 GHG Emissions ($MTCO_2e$)	FY 2008	FY 2013	Increase/(Decrease)	% (+/-)
Natural Gas, Facilities	48,563	27,459	(21,104)	–44
SF_6 Process Losses	27,102	12,001	(15,101)	–56
Other Fugitive Losses	10,660	1,678	(8,982)	–84
Fuel Oil, Facilities	1,968	400	(1,568)	–80
Fleet Fuels	1,104	833	(271)	–25
Other Fuels (equipment)	203	396	193	+95
Biomass Steam Plant	—	1,128	1,128	—
Total Scope 1	89,600	43,895	(45,705)	–51
Scope 2 GHG Emissions	**FY 2008**	**FY 2013**	**Increase/(Decrease)**	**(% +/-)**
Purchased Electricity	249,407	356,508	107,101	+43
Purchased RECs—GHG Avoided	—	(48,848)	(48,882)	—
Net Annual Scope 2 GHG Emissions	249,407	307,660	58,219	+23
Scope 1 & Scope 2 GHG Emissions	**FY 2008**	**FY 2013**	**Increase/(Decrease)**	**(% +/-)**
All Sources, Combined Calculation	339,007	351,555	12,548	+4

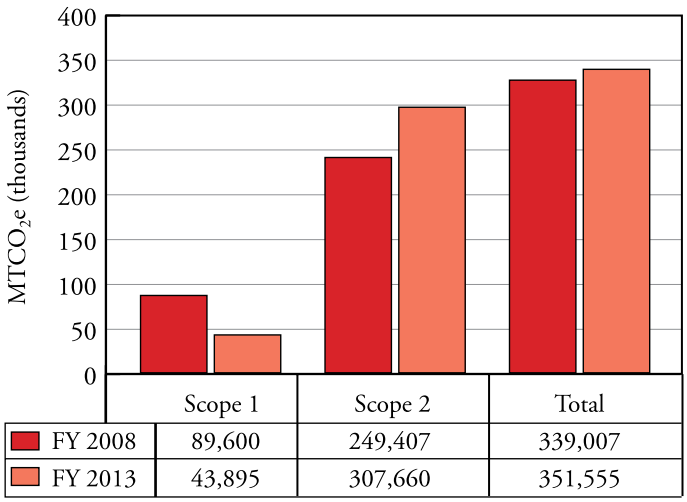


Figure 1. ORNL Scopes 1 and 2 greenhouse gas (GHG) emissions performance status for FY 2013 compared with FY 2008.

and purchase of this potent GHG. ORNL continually evaluates process and purchasing improvements with the potential to reduce SF_6 emissions.

The SF_6 inventory at the end of FY 2013 was about 208,820 lb. Losses during the year totaled 1,107 lb, which was less than the facility baseline of 2,500 lb/year, established as part of the ORNL FY 2008 GHG baseline analysis. Normal process losses vary from year to year because the number of SF_6 transfer cycles from the tandem to storage and back varies from year to year. Losses during a typical transfer cycle are significantly larger than losses during a comparable period while SF_6 is resident in the tandem. In FY 2013, there were only two gas transfer cycles, and all losses were normal process losses.

1.1.2 Plans and Projected Performance

Scope 1 reduction estimates indicate that ORNL is on target to greatly exceed the FY 2020 target reduction goal of 28%. By the target year we expect to see total Scope 1 GHG reductions of 57%. This projected success is based on a number of key projects and initiatives, summarized below.

- Natural gas purchases for steam production will continue to be offset by the BSP operation.
- Fuel oil purchases will decline as more efficient systems are commissioned.
- SF_6 process losses at HRIBF are expected to decline as the tandem accelerator research operation is not currently funded.
- Nonprocess fugitive emissions should continue to decline as research scientists are made aware of less potent alternatives for tracer gases and laboratory research.
- Purchased electricity will grow as critical mission facilities expand to meet national research demands.
- The small modular reactor (SMR) development will be a significant factor in the reduction of Scope 2 GHG emissions.

A major factor for future GHG reductions can be attributed to the anthropogenic GHG emissions for the new BSP that were calculated with the *FEMP Energy and GHG Reporting Tool*, also called the *Federal GHG Workbook*. In FY 2013, the first full year of BSP operation, GHG reductions and energy savings were significant. The plant consumed over 36,300 tons of wood in FY 2013. Currently it is estimated that GHG emissions from natural gas use will decline 51% from the baseline year of FY 2008 by 2020.

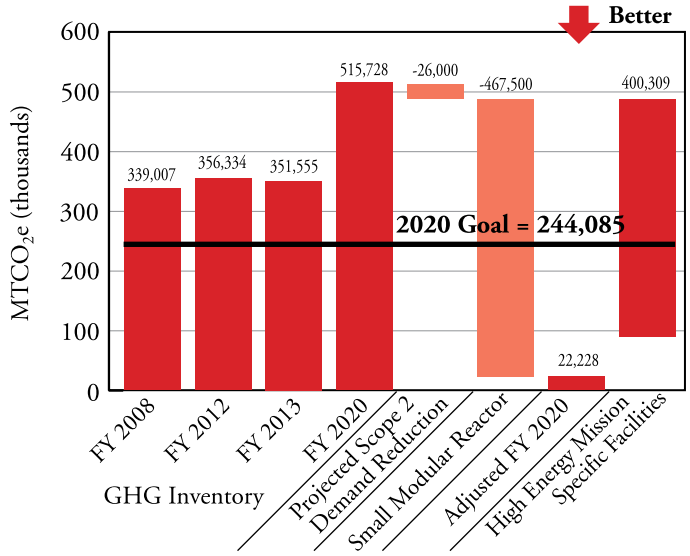
Table 3 shows the various categories of Scope 1 emissions by source, with FY 2008 and FY 2013 actual data and yearly projections to the FY 2020 target year. During this period, Scope 1 GHG emissions are projected to decrease by 57% overall. Continued natural gas emissions savings from BSP and reduced SF_6 emissions are the key players in the success of the ORNL Scope 1 reduction program.

Table 4 shows current projections indicating that while the electricity usage will increase by 144%, associated Scope 2 GHG emissions will increase an estimated 91% for FY 2020 from the FY 2008 baseline (gross annual emissions; assumes we do not use REC purchases as a GHG avoidance strategy). Detailed projections covering the future use of electrical energy resources can be found in Section VI (as requested by the Office of Science guidance).

While Scope 1 emissions are on target for GHG reduction goals, Scope 2 emissions represent a tremendous challenge due to continued growth in electricity demands for mission-critical facilities such as the Spallation Neutron Source (SNS) and the multiple computational science facilities. High energy mission specific facilities (HEMSFs) such as these are among the main drivers of the projected Scope 2 increases. (The importance of the ORNL HEMSFs program is detailed in Section VI of this report.) One of the ways ORNL plans to address these increases is through support of a regional SMR addition, The conceptual plan to assist in the development of an SMR is included as the first project described in Section IV.

Table 4 demonstrates that although electricity use increases by 144% during the goal period, Scope 2 GHG emissions will grow by only 91% due to expected reductions in grid emission rates by our power supplier. 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. As a federal agency, TVA is also expected to play a role in federal leadership in Executive Order (EO)13514 goals. Recent annual reports show that decreases in carbon emissions are being realized, and TVA has stated that its goal is to approach a 50% $MTCO_2e$ factor by 2015 [in FY 2008 the US Environmental Protection Agency (EPA) e-grid rate for the TVA region was 69%], so there is ample room for improvement. As TVA GHG emissions improve, improvements in ORNL's GHG estimates will follow.

ORNL's updated waterfall chart (Figure 2) is used to demonstrate the need for innovative and transformational technologies such as the SMR described in Section IV to help DOE realize the 28% reduction goal for Scope 2 GHG emissions.



Scope 1: Direct Emissions (natural gas, SF_6, fleet vehicles, stacks, hoods)
Scope 2: Purchased Electricity
Scopes 1and 2 FY 2020 Target: 28% reduction from FY 2008 baseline

Figure 2. ORNL greenhouse gas (GHG) reduction plan by source (2020 goal = 244,085 $MTCO_2e$).

Table 3. ORNL Scope 1 GHG emission projections to 2020 (target year)

FY 2013 Data Snapshot	ORNL Scope 1 GHG Projections FY 2008 to FY 2020, $MTCO_2e$									Projection at FY 2020	
	FY 2008	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Increase/ (Decrease)	% (+/-)
Biomass Steam Plant	—	1,128	1,134	1,139	1,145	1,151	1,156	1,162	1,170	—	—
Natural Gas, Facilities	48,563	27,459	26,831	26,295	25,769	25,254	24,748	24,253	23,768	(24,725)	–51
Fuel Oil, Facilities	1,968	400	400	400	400	400	400	400	400	(1,568)	–80
Other Facility Fuels	202	396	310	310	310	310	310	310	310	108	53
Fleet Fuels	1,105	833	816	800	784	768	753	738	723	(382)	–35
SF_6 Process Losses	27,102	12,001	10,624	10,624	10,624	10,624	10,624	10,624	10,624	(16,478)	–61
Misc. Fugitive Losses	10,660	1,678	1,644	1,612	1,579	1,548	1,517	1,486	1,457	(9,203)	–86
Total Scope 1 GHG Emissions	**89,600**	**43,895**	**41,760**	**41,256**	**40,687**	**40,128**	**39,581**	**39,045**	**38,452**	**51,148**	**–57**

Table 4. ORNL electricity projections and Scope 2 GHG emission projections without renewable energy credit purchases

FY 2013 Data Snapshot	Purchased Electricity (Site Base + HEMSF) Projections to FY 2020 (144% Growth)									Projection at FY 2020	
	FY 2008	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Increase/ (Decrease)	% (+/-)
Purchased Electricity (MWh)	362,025	575,833	670,743	726,506	814,984	805,168	855,306	877,715	883,845	521,820	+144
Purchased Electricity GHG Emission Projections ($MTCO_2e$) / Without REC Purchases	Scope 2 GHG Projections to FY 2020 (91% Growth)									Projection at FY 2020	
	FY 2008	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Increase/ (Decrease)	% (+/-)
	249,407	356,508	409,153	435,903	480,841	466,997	487,525	491,520	477,276	227,869	+91

1.2 GHG Reduction—Scope 3

DOE Goal: 13% reduction in Scope 3 GHG emissions by FY 2020 from a FY 2008 baseline (FY 2013 target: 4% reduction).

By definition, Scope 3 GHG emissions include those activities that organizations can influence, but not control, by business processes alone. As with most federal workplaces, ORNL Scope 3 emissions 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
- Employee business ground travel

ORNL continues its overall commitment to communications, aimed at employee engagement. 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. SCI outreach and interaction processes are designed to focus efforts on the reduction of direct and indirect emissions in all areas. Communication is aimed at all levels, management, employees, and contractors, to encourage sustainable practices in the workplace, on the road, at home, and in our communities.

1.2.1 Performance Status

In FY 2013 the total of all categories of Scope 3 GHG emissions was estimated at 42,559 $MTCO_2e$. Overall the Scope 3 inventory grew by 4% from the FY 2008 baseline, so it is not on target to reach the DOE goal of a 13% reduction by FY 2020.

By the end of FY 2013, the ORNL employee workforce had increased 2% from the FY 2008 baseline year. However as Table 5 shows, there was a decrease in the employee commute and business air and ground travel categories during this period. The 6% reduction in employee commute emissions is attributable to the strong engagement with employees, management, and regional resources aimed at reaping the benefits of carpooling, ride shares, and alternative work arrangements. Table 5 demonstrates that while performance in the employee commutes, business air travel, and business ground travel categories has improved, a 23% growth in T&D losses negatively impacted overall performance.

Table 5. ORNL Scope 3 GHG emissions performance status

Scope 3 GHG Emissions Categories	FY 2008 ($MTCO_2e$)	FY 2013 ($MTCO_2e$)	Change ($MTCO_2e$)	Change (%)
Transmission and Distribution Losses	16,429	20,264	+3,838	+23
Employee Commute	16,193	15,224	–969	–6
Business Air Travel	7,204	6,084	–1,120	–16
Business Ground Travel	1,169	987	–182	–16
Other	44	0	–44	0
Total Scope 3	**41,039**	**42,559**	**+1,520**	**+4**

ORNL Transportation Council. The transportation council was established in 2012 as a mechanism to coordinate employee commute options and services successfully worked on issues such as instituting two-person carpool parking to further incentivize carpooling and the establishment of anti-idling policies. Efforts were initiated to develop mechanisms to track the number of people who are teleworking, using alternative work week arrangements, and making use of teleconferencing to avoid business travel. In late 2013, at the request of the bicycle community at ORNL, the council began to evaluate having ORNL participate in the Federal Bicycle Commuter Benefit program.

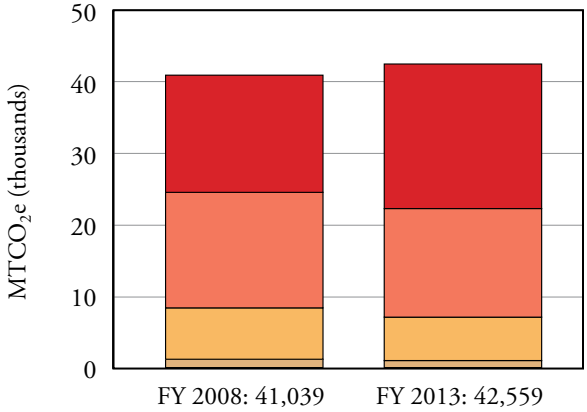
Carpool Promotion and Participation. Through the SCI Employee Transportation Roadmap, ORNL develops and promotes alternatives to the use of single-occupant vehicles by employees. As a result, ORNL has partnered with Smart Trips, a program of the Knoxville Transportation Planning Organization. In 2013, SCI hosted six Smart Trips promotional visits to ORNL. A separate ORNL ride match site was discontinued in 2013 in favor of concentrating on the Smart Trips service. As a result of the outreach and other continuous promotional efforts, ORNL staff participation in the Smart Trips program increased 21% this year, with a total of 101 employees logging 17,655 commute alternative entries into the Smart Trips system. ORNL participated in Smart Trips 2013 X-Treme Commuter Challenge and won the Heavyweight Class. This challenge recognizes companies (more than 2,000 employee category) who employ the most environmentally-conscious commuters. In addition, ORNL captured second place in the overall Business Challenge.

Sara Martin, Smart Trips outreach coordinator, presents first place plaque for 2013 Smart Trips Commuter Challenge (2000+ employee category) to ORNL's Ed Bodey.

Alternative Work Schedules. In addition to the 101 Smart Trips carpool participants, ORNL Human Resources reported that 200 employees were on compressed work week schedules (either what is known as 9/80 or 4/10). In addition, 90 employees have established formal telework agreements. SCI worked with the Human Resources Division to promote the telework policy, gave telework presentations at division and group staff meetings, and provided promotional cards during the 2013 Earth Day celebration.

Through FY 2013, a 16% reduction in GHG emissions from business air travel and business ground travel is due to a better awareness of the benefits of conservative travel and improved teleconferencing tools. Among the specific actions responsible for this decrease was a December 2012 organization-wide email from the ORNL laboratory director concerning the need for all divisions to help with new goals on conference management and conference travel. The goals include greater compliance with conference travel rules that prioritize travel needs, control costs, and help to reduce indirect GHG emissions from air and ground travel. The memo emphasized the benefits of 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. Results from the travel initiative are impressive. For example, in FY 2013 ORNL experienced a 13.4% reduction in the number of air travel entries (trip tickets) and local expense account mileage dropped from 82,264 miles to 49,557 miles.

Promotional card for ORNL Telework Program.



	FY 2008: 41,039	FY 2013: 42,559
T&D Losses	16,429	20,264
Employee Commute	16,193	15,224
Bus. Air Travel	7,204	6,084
Bus. Ground Travel	1,169	987
Other (misc.)	44	–

Figure 3. ORNL Scope 3 GHG emissions for FY 2013 compared with the FY 2008 baseline.

While the employee commute and business travel indicators are showing steady progress, at ORNL, T&D losses represent the largest category of Scope 3 GHG emissions. For the 2013 performance year, ORNL's T&D losses from purchased electricity grew by 23% from the baseline. This is related to the growing consumption of purchased electricity to support ORNL operations and mission-critical facilities.

Figure 3 is a graphic depiction of ORNL's Scope 3 GHG emissions performance for FY 2013 compared with the FY 2008 baseline year. Again, total estimated Scope 3 GHG emissions for FY 2013 equal 42,559 $MTCO_2e$ and represent an overall growth of 4%, attributed to the increase in T&D emissions and buffered by decreases in other areas.

1.2.2 Plans and Projected Performance

Because of the nature of Scope 3 emissions and the fact that such emissions are beyond the direct control of organizations, reductions are dependent upon strong communication with our employees and regional partners. At ORNL, SCI is the primary management tool to ensure progress toward Scope 3 reductions related to employee commutes and business air and ground travel, using employee engagement in the attainment of the established goals. The rural setting of ORNL is a barrier to the development of public transportation options; therefore, a key for SCI is to continue promoting alternative commuting options (bike, carpool, vanpool) and alternative work schedules

The following are the main activities currently being conducted to meet the Scope 3 emissions reduction goals in EO 13514. Figure 4 is ORNL's Scope 3 updated waterfall chart.

Electricity transmission and distribution loss-related efforts

Because the largest portion of Scope 3 GHG emissions is attributed to T&D losses from purchased electricity, Scope 3 emissions (in total) are expected to increase as we approach the FY 2020 target year. ORNL projects a growth of 144% in the consumption of purchased electricity from the baseline of FY 2008. The additional electrical purchases will also incur additional T&D losses and their emissions. The reduction of GHG emissions as a result of T&D losses is dependent upon our 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 (OSO) and ORNL have taken steps to strengthen those bonds in recent years. ORNL is involved in many planning and working committees with TVA, the provider of site electrical power. ORNL has taken a proactive position and included TVA as a key member of the ORNL solutions team for Scope 2 GHG reductions, including support of the SMR, which will also reduce T&D losses. Additionally, ORNL is exploring the feasibility of using a new substation to transfer loads to a point-of-service closer to the programs served to potentially reduce T&D losses on-site and improve reliability of the electrical service. In summary, the risk of nonattainment of the Scope 3 GHG reduction goal of 13% is high, primarily because of T&D losses from growing demand for purchased electricity without a significant improvement in TVA's generation and transmission/distribution capabilities.

Transportation-related efforts

- Continue to maximize transportation coordination and community outreach by coordinating with local, state, and federal telecommute and rideshare agencies, including further development of regional transportation planning partnerships such as Smart Trips.
- Conduct employee outreach and education to increase participation in commuting alternatives. Maintain and update the telework website, continue green commute challenges and Earth Day promotions, update student orientation materials, hold telework outreach sessions, promote rideshare matching, monitor the rideshare database and rideshare parking permit system, collect data from Human Resources on alternate work schedule participation, and follow up with a staff survey to collect current driving patterns and behaviors.
- Continue to promote and educate staff on the benefits of telework arrangements to achieve an increase in telework participation.

Highlight on the ORNL Biomass Steam Plant, an Operations and Research SHOWCASE

The biomass steam plant (BSP) project facts for sustainable operations and greenhouse gas reduction from FY 2013 to FY 2020—

- The new BSP utilizes biomass fuel to provide the steam baseload for ORNL. Four dual-fuel (natural gas and fuel oil) boilers were replaced by the BSP, but two dual-fuel boilers remain to supplement the BSP steam production.
- This innovative, advanced energy project, using renewable energy resources, furthers the widespread use and adoption of alternative biofuels reducing the dependence upon traditional fossil-fuel-based energy sources.
- BSP incorporates conservation strategies, applies innovative biomass gasification technologies, and uses domestic, local biomass fuel sources. Local biomass sourcing is a sustainable enhancement for the regional economy.
- BSP offers multiple opportunities for research including fuel analysis, synthetic gas analysis, feedstock testing such as different types of wood and switchgrass, process metering and monitoring, corrosion science, residual fuel analysis, and waste ash for agriculture.
- This project also provides both educational and outreach opportunities promoting public awareness of the environmental benefits of BSP, is an avenue for potential partnerships with universities for study, and is a SHOWCASE for visitors and researchers.
- Annual cost savings are projected at $3.8 million per year.
- BSP augments applied renewable energy research at the newly constructed Bioenergy Science Center.
- The comprehensive, integrated research and demonstration approach used in this project will provide concrete data supporting other facilities implementing BSP operations within the state of Tennessee and across the country.

Business air-and-ground-travel–related efforts

In response to recent initiatives (EO 13589 and Office of Management and Budget Memorandum M-12-12), ORNL has focused attention on the need to reduce travel-related expenditures and emissions and has been in the process of re-architecting the video teleconference infrastructure for the laboratory. Using the Blue Jeans Network, this new strategy has revealed that technologies are converging which make it easy to interconnect mobile, desktop, and room-based video telepresence systems in a very flexible manner. Recent successes with the pilot program have provided confirmation that embarking on a deployment strategy to create two new room-based facilities per year and unlimited desktop and mobile access can deliver significant business value proposition. To date, more than 20 meeting hours of successful videoconferencing have been achieved across more than 11 disparate locations, delivering significant savings in the form of travel expense avoidance.

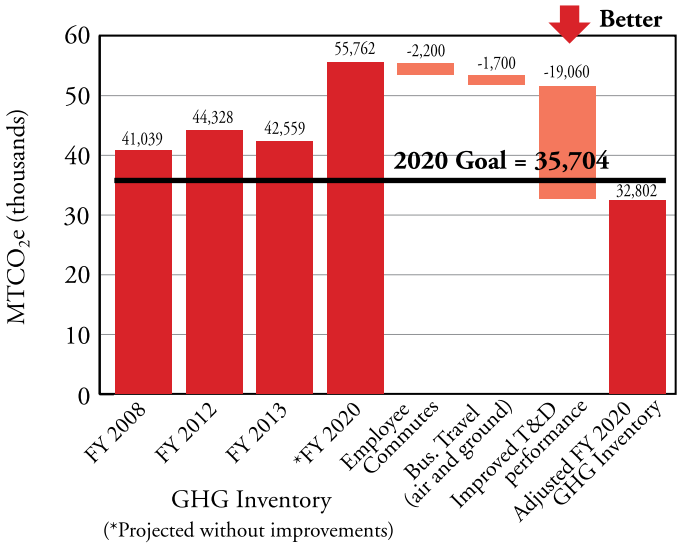


Figure 4. ORNL greenhouse gas Scope 3 snapshot.

Goal 2: Buildings, Energy Savings Performance Contract Initiative, and Regional and Local Planning

2.1 Energy Intensity Reductions

DOE Goal: 30% energy intensity reduction (Btu/GSF) by FY 2015 from a FY 2003 baseline (FY 2013 target: 24% reduction).

2.1.1 Performance Status

ORNL has continued to make steady progress toward meeting or exceeding the goal of reducing energy intensity by 30% by FY 2015 from a FY 2003 baseline (Figure 5). The FY 2013 energy use intensity (EUI) reduction is 46.5%, greatly exceeding the 30% goal. This is the result of a combination of factors, including continued construction of new energy-efficient facilities, repurposing of existing facilities to better align with missions and resources for effective operations, and demolition of inefficient legacy facilities. Aggressive energy reduction activities in current facilities will be combined with ongoing audits and the ECMs program, ESPCs, new efforts in building commissioning, benchmarking energy consumption, and best management practices. As demonstrated in Figure 6, over the past decade, the footprint of ORNL's offices and laboratories has increased by 52%, accompanied by a 29% decrease in energy consumption (with the exclusion of biomass consumption in the EUI calculation).

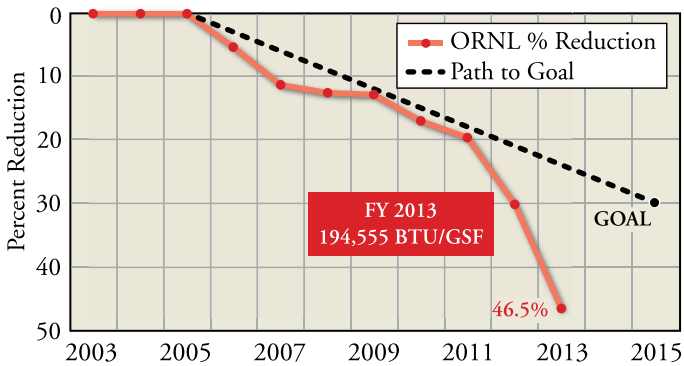


Figure 5. Summary of energy intensity results and progress toward goal.

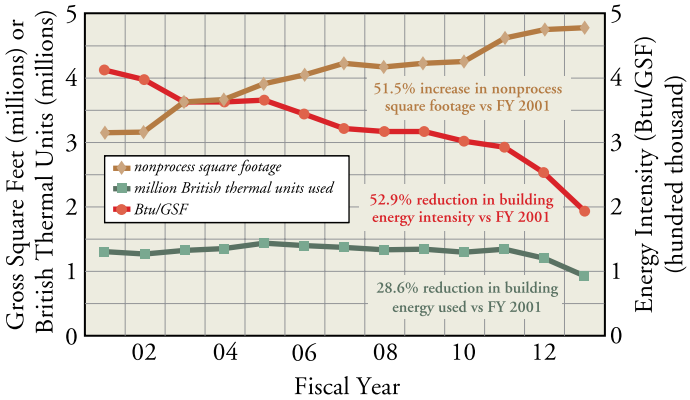


Figure 6. ORNL building energy performance for the last decade.

Based on FY 2013 data, energy use in the buildings category at ORNL is 932.666 billion Btu [not including ORNL's excluded facilities as defined by the Energy Policy Act (EPACT) of 1992 or the biogenic carbon content of biomass fuel consumption per DOE guidance]. Given the area of 4,793,837 gross square feet (GSF) of energy-consuming (EC) buildings, trailers, and other structures/facilities identified in the Facilities Information Management System (FIMS), the FY 2013 calculated EUI is 194,555 Btu/GSF, which represents a 23.4% reduction compared to FY 2012.

The FY 2013 current performance EUI is based on the FIMS building and trailer EC area of 4,443,417 GSF plus the other EC structures/facilities buildings area of 350,420 GSF for a total of 4,793,837 GSF.

At ORNL, the ESPC with JCI is the primary mechanism for achieving the goals established to meet the EPACT directives. A delivery order with JCI was awarded in July 2008 and formally accepted in July 2012. The ESPC/ECMs included steam system decentralization, lighting upgrades, water conservation, building management system improvements, mechanical equipment upgrades, and a biomass steam production system.

One significant ECM, the BSP, has been operating since July 2012, so a full year's benefits have now been realized in the EUI calculation for FY 2013.

One component of the steam decentralization ECM, de-energizing the steam distribution line to the Melton Valley Steam Plant (MVSP), was not completed until the fall of 2012. The MVSP has been operating without assistance from the BSP, and the distribution line has been removed.

In recent years, additional ECMs, not addressed by the ESPC, have been implemented to further reduce energy use. These additional measures include Energy Star assessments and related actions; improvements in heating, ventilation, and air conditioning (HVAC) equipment; lighting improvements; replacing motors with more efficient units; and improving the efficiency of the steam distribution system.

2.1.2 Plans and Projected Performance

ORNL has made significant progress in energy intensity reduction by driving beyond the 30% reduction goal. The focus now is on maintaining this reduction while continuing to strive for improvement. This objective will be supported by the continued operation of the BSP and the performance of other ESPC implemented ECMs as well as an enduring in-house energy management effort.

ESPC status updates given regularly by JCI show that ECM performance is meeting or exceeding goals. This progress is exemplified by a continued reduction of HVAC simultaneous heating and cooling due to further optimization of HVAC controls. Measurement and verification of ESPC ECM performance continued in FY 2013.

ORNL's in-house energy management strategy revolves around utility meter data. This meter data will provide the basis for benchmarking, which sets priorities for energy auditing. Energy audits identify ECMs that will often include retro or recommissioning efforts. To sustain the resulting performance and savings, ongoing commissioning will leverage utility meter and Building Automation System (BAS) data for monitoring trends and identifying anomalies.

Based on persistent savings from ECMs and aggressive energy innovation in the construction, repurposing, and renovation of buildings, we anticipate the EUI goal of 30% reduction will be exceeded in the FY 2015 goal year (Figure 7).

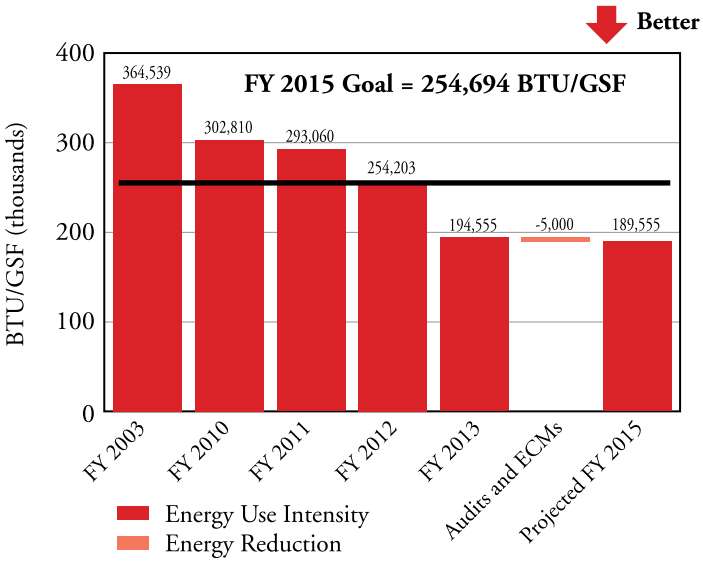


Figure 7. Energy use intensity improvement: 2003 vs 2015.

2.2 Energy Independence and Security Act Section 432 Energy and Water Evaluations

DOE Goal: Each year evaluate a minimum of 25% of 75% of Facility Energy Use over a 4-Year Cycle per Energy Independence and Security Act Section 432.

2.2.1 Performance Status

ORNL has made good progress on the energy audit program, having completed the first year of another 4 year cycle in FY 2013. Section 432 of the 2007 Energy Independence and Security Act requires that 25% of 75% of facility energy use be audited each year, with audits repeated on a 4 year cycle. Also, evaluation by an energy service

Table 6. ORNL energy audit results in annual square footage and percentage of campus

Year	Annual Square Footage	Annual Percent of Campus	Cumulative Square Footage	Company
2008	3,195,365	100	3,195,365	JCI (ESPC)
2009	1,294,069	40.5	4,489,434	V3
2010	627,382	19.63	5,116,816	Keres/EMG
2011	470,563	14.73	5,587,379	Keres/EMG
2012	775,596	24.27	6,362,975	Keres/EMG
2013	963,160	30.14	7,326,135	Working Buildings

company (ESCO) for a site wide initial proposal in preparation for an ESPC is acceptable as fulfilling this 4 year requirement.

The JCI ESPC evaluation in FY 2008 provided the first 100% audit of the ORNL campus (Table 6). In FY 2009, although doing so was not required at that time because of the JCI initial proposal, ORNL chose to proceed with the second round of audits to provide additional detail on potential ECMs that could be carried out using in-house operating staff and funds. This also provided a ready list of ECMs in the event supplemental funds were provided. This second round of audits, completed in FY 2012, evaluated 3.2 million ft^2 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 proved very successful in identifying opportunities for HVAC optimization that require only minor capital modifications and leverage the power of retrocommissioning.

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 ordered by life-cycle cost and benefit analysis, but secondary factors are also taken into consideration to facilitate alignment with current opportunities and identify measures that have the best potential for implementation.

2.2.2 Plans and Projected Performance

In FY 2014 and foreseeably through the remainder of this cycle of audits, ORNL will continue with the approach of focusing American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) level 2 in-depth audits on energy and water issues. Specific emphasis will continue to be applied to ensuring the quality and feasibly of recommended energy and water conservation measures. It is for this reason that a hold point has been introduced to the process that promotes a feasibility evaluation of a preliminary energy and water conservation measures list before further details are developed. In addition to these audits, ORNL will engage in-house facility managers and facility engineers to identify lighting, building envelope, and other energy-impacting opportunities that become apparent through the course of their daily tasks. By quantifying the energy economics associated with these opportunities, ORNL's sustainability and energy efficiency personnel will aid facilities personnel in the organization and prioritization of these items to garner the attention that they deserve.

2.3 Individual Buildings Metering

DOE Goal: Individual buildings or processes metered for 90% of electricity by October 1, 2012, and for 90% of steam, natural gas, and chilled water by October 1, 2015.

2.3.1 Performance Status

FY 2013 percentages, calculated as of November 2013, are as follows.

- 90.3% electrical
- 94.4% natural gas
- 6.5% steam
- 67.8% chilled water

ORNL's specific status with respect to each requirement and/or goal is as follows.

- "Meter at a building level 75% of electricity use at each site by October 1, 2011 (all electricity use at stand-alone buildings and 75% of electricity used at multi-building campuses), working toward a goal of 90% by October 1, 2012."
  - ORNL is currently metering in excess of 75% of building-level electricity use.
  - At an achievement rate of 90.3%, ORNL has met the October 1, 2012, goal of metering 90% of building electrical use.
  - ORNL is metering 100% of data centers with significant submetering within data centers.
- "Meter at a building level 10% of natural gas, steam, and chilled water use at each site by October 1, 2011 (all resource use at stand-alone buildings and 75% of resources used at multi-building campuses), working toward a goal of 90% by October 1, 2015."

- ORNL is currently metering natural gas at 94.4% and chilled water at 67.8%, well above the required 10% level for October 1, 2011, and above the interim goal of 40% for FY 2013, while progressing toward 90% by FY 2015.
- ORNL is metering all steam output and has implemented limited metering of steam use at 6.5% at the building level. ORNL is working to expand the building level steam metering to achieve the 90% goal by FY 2015.

- "Meter 40% of agency data centers by October 1, 2011, working toward a goal of 100% by October 1, 2015."
  - ORNL is currently metering 100% of data centers with significant submetering in data center applications, placing the site in compliance with the 2015 mandate.
- In addition, any new buildings will include metering to ensure this mandate is met.

2.3.2 Plans and Projected Performance

During FY 2013, significant progress was made in growing ORNL's advanced metering infrastructure with many new devices installed in the electrical, steam, and chilled water systems. This momentum will continue into FY 2014, with primary focus on the steam distribution system because of its size and technical complexity. Lessons learned from steam meter installations in the last 2 years will provide a good foundation for proficient deployment in FY 2014. Efforts will also continue on development of the chilled water energy metering infrastructure. Most high-priority chilled water loads are already metered, so now the focus will shift to closing gaps and enhancing the big picture for consumption. Attention will also be given to district compressed air to identify the largest loads on the system and to plan for meter installations to more closely monitor the frequency and magnitude of end uses.

The Central Energy Data System (CEDS) will continue to be enhanced as more connected devices are brought online and the system's user group continues to grow. In the near term, plans are being made to develop interactive mechanical utility distribution system diagrams for an intuitive representation of meter locations and improved ease of system navigation. Interactive one-line diagrams for medium-voltage electrical distribution and computational facilities are already in the system, and plans are being made to expand this concept to other buildings with advanced electrical meters. New user system training and refresher training will continue to be an essential part of the CEDS support strategy. To promote energy awareness and engagement of ORNL's general employee population, digital dashboards will be developed for building installed kiosk monitors that will use metered energy data sources. Continuous efforts will be made to maintain updated documentation of site meter inventory details and operational status. Processes will be refined to manage calibration and other actions required to maintain the integrity of the system and its data.

2.4 Cool Roofs

DOE Goal: All new roofs must meet cool roof reflectivity standards and have thermal resistance of at least R-30.

In FY 2013 ORNL continued to enforce cool roof strategies for all new building projects and for all reroofing projects where it was physically and economically feasible. While highly reflective and heavily insulated roof systems make up the bulk of new roofing, other strategies such as earthen roof systems and photovoltaic (PV) systems are also considered as options and have been used on roofs. An insulation value of R-30 is the standard design specification for occupied facilities. As part of FIMS reporting, cool roof construction is updated and coordinated biannually to ensure compliance with DOE goals.

2.4.1 Performance Status

In FY 2013, ORNL completed one new roofing project, the Chestnut Ridge Maintenance Shops. This roof is a two-level roof, highly reflective, with R30 insulation, and covers 13,105 ft^2. There were no new reroofing projects completed this fiscal year.

2.4.2 Plans and Projected Performance

No change.

2.5 High Performance Sustainable Buildings—Existing Buildings

DOE Goal: 15% of existing buildings greater than 5,000 GSF to comply with the five guiding principles of HPSB by FY 2015, with progress to 100% thereafter.

2.5.1 Performance Status

In FY 2013, ORNL can proudly announce that 23 buildings meet the high performance sustainable building (HPSB) guiding principles (GPs), which exceeds the DOE target of 22 HPSBs—two years ahead of schedule. During 2013, ORNL's Buildings 1060, 1505, 1506, and 6012 were evaluated and found to align with the GPs for federal leadership in HPSB.

More than ever before, existing buildings must be driven to perform at a higher level with emphasis on sustainability. ORNL's systematic approach to identifying HPSB candidates and applying the GPs has proven effective in keeping us on track to meet the FY 2015 requirements. HPSB candidates have been identified based on building space use, existing metering infrastructure, and initially identified energy conservation opportunities. Action plans for achieving building specific GPs are developed and executed while laboratorywide standards are used to fulfill HPSB policies and procedures. The engagement of facility managers, facility engineers, and other technical facility personnel has proven crucial in 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 developed. Lessons learned in the FY 2012 HPSB Joint Institute for Biological Sciences Building 1520 were applied to laboratory Buildings 1060, 1505, and 1506 in FY 2013. In these buildings the focus was on evaluating the operation of existing systems and their suitability for the facilities. Temperature and airflow setpoints and equipment operating sequences were examined with the intent to 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 furniture task lighting was found to support the GPs.

A substantial renovation of office Building 6012 in FY 2012 presented an opportunity to implement lighting controls and high efficiency HVAC systems to align with GPs. Advanced meter installations were conducted in FY 2013, and the HPSB checklist for the building was completed.

While all of the GPs contribute to the betterment of buildings, the retrocommissioning process has proven 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, setpoints, 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 plan-do-check-act cycle to ensure the persistence of savings and potentially even increase them over time.

Following this formula for success, ORNL added four additional existing buildings to its HPSB portfolio in FY 2013. Figure 8 reflects ORNL's status and plans for HPSBs—existing and new construction.

2.5.2 Plans and Projected Performance

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 or even improved. Specifically this will involve ongoing commissioning techniques, maintaining benchmarks, and verifying that policies and procedures remain current, visible, and in use. As buildings become increasingly challenging to approach with the GPs, intensive effort and often capital investment is required to make significant changes toward energy consumption reduction. 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 in the current inventory.

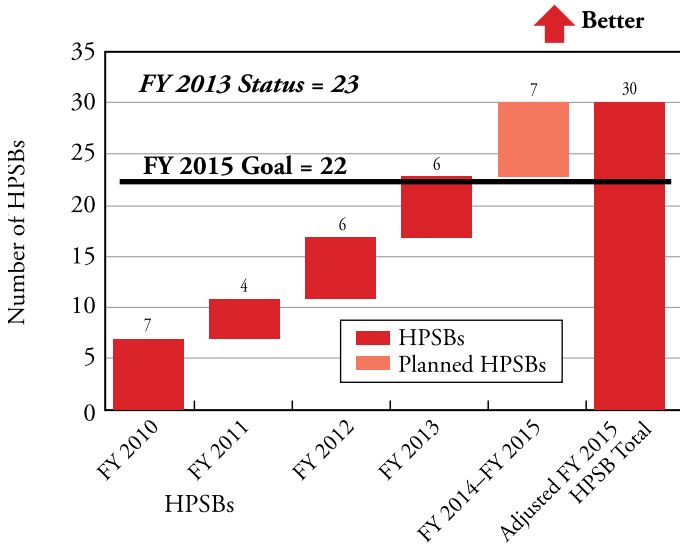


Figure 8. ORNL plan for high performance sustainable buildings (2015 goal = 22 HPSBs).

2.6 High Performance Sustainable Buildings—New Construction

DOE Goal: All new construction, major renovations, and alternations of buildings greater than 5,000 GSF must comply with the GPs.

2.6.1 Performance Status

As of the end of FY 2013, ORNL has one of the largest collections of LEED-Certified buildings on a single campus in the entire Southeast. Currently, 16 facilities have been constructed to LEED standards at ORNL, 5 LEED Gold and 2 LEED Silver. LEED certification has either been received or is in progress for the following facilities:

1. Building 1521—ORNL West End Research Support Facility (LEED Certified)
2. Building 3625 (expansion)—Advanced Materials Characterization Laboratory (LEED Silver)
3. Building 4020—MAXLAB Building Research Laboratory (LEED Gold)
4. Building 4100—Chemical and Materials Science Laboratory (LEED Gold)
5. Building 4500N—Wing 3 Renovation (in construction, designed for LEED Gold)
6. Building 5100—Joint Institute for Computational Sciences (LEED Silver)
7. Building 5200—ORNL Conference Center (LEED Certified)
8. Building 5300—Multiprogram Research Facility (LEED Gold)
9. Building 5600—Computational Sciences Building (LEED Certified)
10. Building 5600 (expansion)—Multiprogram Office Complex (LEED Gold, pending)
11. Building 5700—Research Office Building (LEED Certified)
12. Building 5800—Engineering Technology Facility (LEED Certified)
13. Building 7990—Melton Valley Warehouse (LEED Certified)
14. Building 7995—Melton Valley Maintenance Facility (LEED Gold)
15. Building 8630—Joint Institute for Neutron Sciences (LEED Certified)
16. Building 8640—ORNL Guest House (LEED Gold) (First LEED Gold Hotel in State of Tennessee)

2.6.2 Plans and Projected Performance

The following planned facilities will be designed to achieve LEED Gold and qualify for equivalency for meeting the DOE HPSB GPs:

- Building 8930—Chestnut Ridge Maintenance Facility (designed for LEED Gold) in FY 2014.
- Building 7018, Logistic Services Center Building—in design; scheduled for construction completion in the second quarter of 2015.

2.8 Regional and Local Planning

DOE Goal: ORNL continues to be actively engaged in regional and local planning for transportation options as well as outreach activities for the enhancement of sustainability effort in the entire southeast region.

Performance Status

Transportation-related 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 2013, SCI coordinated with state and regional transportation programs to help create more effective, efficient, and affordable regional transportation and commuting options. Related activities included the following.

Coordinating with local, state, and federal telecommute and ride-share initiatives. Specific efforts included the following.

- Expansion of Smart Trips participation by ORNL employees. As employee commuting is a major contributor to Scope 3 GHG emissions, see Section II, Goal 1.2 (GHG Reductions—Scope 3), for a detailed description of FY 2013 Smart Trips activities, plans and results.
- Participation as a member of the Knoxville Regional Transit Development Plan process to expand transit opportunities across the region and in the Pellissippi Parkway corridor.

Participation in the joint US Department of Housing and Urban Development–US Department of Transportation Regional Sustainable Development Consortium (Plan East Tennessee or PlanET), and coordination of ORNL sustainability efforts with the efforts of the PlanET member communities and consultants.

Other Regional and Local Sustainability Planning Activities

In August of 2013, ORNL led the 3rd Annual Southeast Sustainability Summit in partnership with the Tennessee Department of Environment and Conservation and the city of Knoxville, with close to 300 from around the Southeast in attendance.

- The goals of the Summit were to (1) share knowledge, (2) share best practices in terms of implementation strategies, and (3) further develop a Southeast Regional Sustainability process.
- The Summit gave institutions, businesses and industry the opportunity to learn about and promote sustainability efforts in all sectors.
- The agenda covered topics as diverse as sustainable transportation, low-interest energy loans, changing behaviors in the workplace, and energy savings performance contracts.
- Keynote addresses were delivered by John L. Knott Jr. of City-Craft Ventures, Kateri Callahan of the Alliance to Save Energy, Lee Ann Head of the Shelton Group, and Mike Vandenbergh, Law Professor at Vanderbilt University

During the summit, ORNL announced a new nonprofit sustainability organization, the Southeast Sustainability Group (SSG, http:// www.southeastsustainabilitygroup.org). SSG comprises research, academic, and industry partners throughout the southeastern United States with a shared vision for advancing sustainability in the region—defined primarily as the US Environmental Protection Agency's Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and American Indian groups in the region). Initially SSG will focus on sustainable transportation, low-carbon power generation, and water and waste management. In addition to ORNL, other SSG members include Black Bear Solar Institute (Pigeon Forge, Tennessee); Clark-Atlanta University; Indian River State College (IRSC), Florida; Nissan North America; the Tennessee Valley Authority; and the University of Tennessee-Knoxville.

As a result of the first ORNL Summit and the regional process, IRSC and ORNL entered into a Work-for-Others agreement. Under this agreement ORNL has been consulting with IRSC on the development of a sustainable campus initiative at IRSC patterned after the ORNL SCI. During FY 2013, three on-site workshops were held: (1) January 2013 workshop topic was building efficiency; (2) April 2013 workshop topic was renewable energy; and (3) September 2013 workshop topics were on waste management, water management, sharing successes, building envelop and equipment technology, and IT energy reductions. A new strategy was included during workshops 2 and 3 so IRSC would get the most exposure to ORNL subject matter experts (SMEs). At each of those two workshops two ORNL SMEs were on-site at IRSC and then multiple SMEs provided presentations via video teleconferencing, which worked extremely well. IRSC was very pleased with how smoothly the process worked, and having the opportunity to speak with multiple SMEs made for successful workshops.

ORNL received the GreenGov Presidential Good Neighbor Award, November 2013, for working with IRSC to create a sustainable campus and for partnering with the electric vehicles (EVs) charging project in Tennessee.

As a result of our reputation for leadership in sustainable practices, ORNL SCI was invited to serve as a member on the sustainability teams of two neighboring municipalities (Roane County and the City Oak Ridge). ORNL shared sustainability best practices in key impact areas that affect both communities. The municipalities were invited by TVA to participate in the TVA "Valley Sustainable Communities" program. ORNL was committed to supporting the program because the DOE Oak Ridge Office (ORO) geographic boundary reaches into both of these areas. The City of Oak Ridge achieved Platinum status and Roane County achieved Silver status under the program. The new designations will help these municipalities be more competitive as they strive for job growth and economic development. By showing a commitment to sustainable practices and integrated development, they are in a better position to attract new businesses and to encourage the expansion of existing employers.

GreenGov Presidential Awards ceremony (from left): Nancy Sutley, Chair of Council on Environmental Quality; Melissa Lapsa and Teresa Nichols, ORNL Sustainable Campus Initiative; Johnny Moore, DOE Office of Science, ORNL Site Office; Jennifer MacDonald, Director, DOE Sustainability Performance Office; and Dr Michael Knotek, DOE Deputy Under Secretary for Science and Energy.

Plans and Projected Performance

- Further develop the regional transportation planning partnerships with Smart Trips and Knoxville Area Transit.
- Continue to participate in the Knoxville Regional Transit Development Plan to promote and coordinate ORNL's commute/transit needs with the long-range transportation strategy for the region.
- Continue to participate in the PlanET regional consortium, sharing sustainability lessons learned with regional leadership.
- Continue SSG progress.
- Foster additional workshops between ORNL and IRSC.

Goal 3: Fleet Management

3.1 Fleet Alternative Fuel Consumption

DOE Goal: 10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline.

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 (GGEs).

3.1.1 Performance Status

Alternative fuel use in 2013 was 68% of total fuel consumption. In terms of the long-term target, alternative fuel use has increased from 35,819 gallons in 2005 to 114,469 gallons in FY 2013, a total 219% increase.

An idle reduction guide and an accompanying compendium of idle reduction statements were finalized in FY 2013 to promote a culture of reducing unnecessary idling for all nonemergency vehicles operating both on campus and off campus. The ORNL Idle Reduction Guide will continue to be promoted through on-site communication with ORNL employees regarding the benefits of reducing idling for ORNL fleet vehicles, as well as their personal vehicles. One of the strategies to support this effort is to post idle reduction signage in heavy traffic locations to remind staff, vendors, and subcontractors of the importance of non-idling practices. To that end, 12 new signs have been installed to reinforce ORNL's commitment to idle reduction.

ORNL shipping-receiving loading dock, showing signage for anti-idling campaign.

There were fewer reports of fuel problems for E85 and B20 in FY 2013 than in previous years. E85 fuel quality is frequently tested using an outside fuel test laboratory to ensure ethanol content. Any interruptions in the supply or integrity of alternative fuels in the ORNL fleet can quickly lead to reduced alternative fuel use (and concomitant increased petroleum use), which will impact our ability to meet federal requirements. E85 use has steadily improved over the course of the year, as shown in Figure 9, as a result of laboratory management bringing the importance of using E85 in flexible fuel vehicles (FFVs) to the attention of drivers.

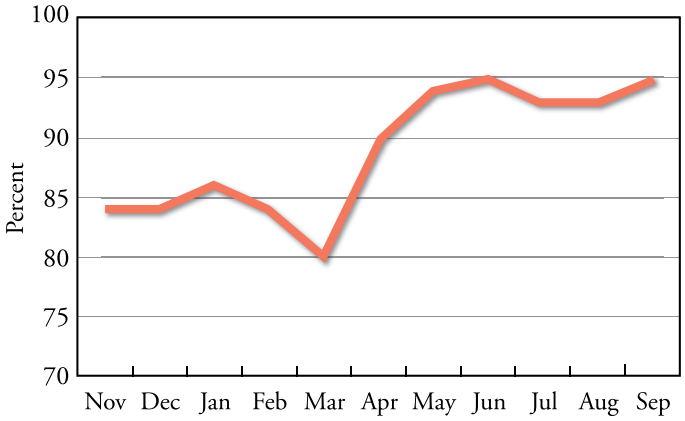


Figure 9. E85 fuel use in flexible fuel vehicles for FY 2013.

To ensure that all drivers of ORNL FFVs have the opportunity to use E85, an additional dispenser was installed at the E85 fuel pump at the site fuel station.

ORNL's second E85 fuel pump

Through a continued partnership with East Tennessee Clean Fuels (DOE Clean Cities), ORNL SCI had a presence at all of the Knoxville area Earth Day events, as well as other education and outreach events focusing on alternative fuels and advanced vehicle technologies. ORNL's presence at local events, with example vehicles and experts, helps bring awareness to local communities of the availability, benefits, and challenges associated with using more sustainable modes of transport. A vehicle display focusing on EVs and plug-in EVs (PEVs) was also organized for the ORNL Earth Day event. Another example of leadership is ORNL's organizing and participating on a special panel on sustainable transportation for the third annual ORNL Southeast Sustainability Summit, which included speakers from ORNL, the local Clean Cities program, and a natural gas expert.

3.1.2 Plans and Projected Performance

ORNL's planned fleet measures include continuing to replace older vehicles with alternative fuel vehicles (AFVs) as funding allows and procuring electric low-speed vehicles (LSVs). Currently, 27% of the LSVs at ORNL are electric.

To ensure there are no missed opportunities for fueling AFVs with alternative fuels, fleet management will continue to monitor AFV fuel use on a monthly basis.

In November 2012, ORNL finalized the transfer of two 2011 diesel hybrid 36-passenger buses from Idaho National Laboratory. This transfer replaced a 1995 24-passenger gasoline-fueled bus and a 2000 24-passenger diesel-fueled bus in ORNL's fleet.

ORNL received appropriations to purchase three passenger-carrying vehicles in FY 2013. One of these vehicles is a Ford C-Max Energi plug-in hybrid, and the other two are FFVs.

Budget reductions will impact the purchase of electric and hybrid replacement vehicles. To purchase passenger-carrying AFVs, ORNL must be granted approval by congressional appropriation to DOE headquarters. The uncertainty associated with appropriations impedes the fleet planning, including goals for purchasing AFVs.

3.2 Reductions in Fleet Petroleum Consumption

DOE Goal: 2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline.

Fleet vehicle data are available in the FAST System. Fuel calculations are in natural units of gallons, not GGEs.

3.2.1 Performance Status

The DOE goal for this area requires that ORNL fleet petroleum consumption in 2013 be reduced by 16% from the FY 2005 baseline. In FY 2013, ORNL had achieved a 53% cumulative petroleum fuel reduction based on the 2005 baseline.

To ensure continued success in this area, ORNL is continuing to increase use of alternative fuels, increasing the fuel economy of fleet vehicles, and reducing the number of vehicle miles driven. ORNL has strategically placed 100 bicycles throughout the campus for staff use in an attempt to further reduce petroleum fuel consumption.

3.2.2 Plans and Projected Performance

As funding is provided and the appropriate approvals are granted, 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 procure electric LSVs to replace gasoline-fueled LSVs.

ORNL's planned fleet measures include the following.

- Zero waivers for using petroleum fuel in AFVs
- Zero missed opportunities for fueling AFVs with alternative fuels
- Continuing to replace older vehicles with AFVs and hybrids as funding allows
- Continuing to implement initiatives that will decrease idling practices by personnel
- Obtaining hybrid vehicles to provide the on-site taxi/shuttle activity with more fuel-efficient vehicles
- Reducing vehicle miles traveled through teleconferencing, trip consolidation, use of mass transportation, etc.

The risk associated with this goal is the assumption of the availability of alternative fuels. ORNL currently has four types of fuel available on-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.

3.3 Purchase of Alternative Fuel Vehicles for Light-Duty Vehicles

DOE Goal: 100% of light-duty vehicle purchases must consist of AFVs by FY 2015 and thereafter (75% FY 2000–2015).

3.3.1 Performance Status

ORNL continues to support the 75% AFV acquisition requirement by purchasing available FFVs from the General Services Administration (GSA). These purchases will remain dependent upon available funding and approval. Nine light-duty FFVs and one plug-in hybrid were purchased, which resulted in 100% AFV acquisitions in FY 2013.

3.3.2 Plans and Projected Performance

ORNL will continue to replace vehicles that meet the 41 CFR 102-34.270 criteria with AFVs as funding and appropriations allow.

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

3.4 Fleet Inventory—Rightsizing the Fleet

DOE Goal: Reduce fleet inventory of non-mission-critical vehicles by 35% by FY 2013 relative to a FY 2005 baseline.

Submit Rightsizing the Fleet Management Plan for approval by December 31, 2012. Identify mission critical/non-mission-critical vehicles by December 31, 2012.

ORNL completed its mandated fleet reduction of 58 vehicles in FY 2012. On January 31, 2013, ORNL received confirmation that no additional fleet reduction or inventory submission is needed.

3.4.1 Performance Status

On January 31, 2013, ORNL received confirmation per email from Caryle Miller (on file) that the Office of Science had reached its fleet reduction goals as of December 31, 2012, and that ORNL's commitment for this goal had also been met.

3.4.2 Plans and Projected Performance

Not applicable.

Goal 4: Water Use Efficiency and Management

4.1 Potable Water

DOE Goal: 26% reduction in potable water intensity (G/GSF) by FY 2020 from a FY 2007 baseline (FY 2013 target: 12%).

ORNL has long been aware of the benefits of effective water management. Current sustainability programs have set DOE reduction goals relative to a FY 2007 baseline. As a result of a variety of operational initiatives, ORNL had already experienced a 50% reduction in water use by FY 2007 compared with its highest water use established 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 was a water use intensity (WUI) of 145 MG/GSF in FY 2013, a reduction of 18% since FY 2007, which exceeds the FY 2013 goal of a 12% reduction.

Significant WUI improvement activities were initiated in FY 2008 upon the award of an ESPC, resulting in savings of 170 MGY. 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 in the process of replacing lines, discovered and repaired leaks. An effort by the Facilities Management Division 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.

A "Fix-A-Leak" program was introduced to increase ORNL staff awareness of the costs of leaks, both economic and environmental, and encourage them to report problems. The Fix-A-Leak initiative also promotes the awareness of water use and savings in the home. Facilities Management staff have also assessed buildings and repaired leaks that would not be evident to the general staff.

The commissioning of Building 4100 moved historically inefficient operations from Buildings 3137, 3150, 4508, 4500N, and 4500S. Another heavy user, the Physics Division in Building 6000, has implemented a project to drastically reduce its use of OTC by installing flow control valves and eliminating cooling water entirely when air-cooled fans could be used.

To better understand water use at ORNL, a water-metering plan is being implemented. As a part of this plan, assessments identified the 33 facilities that account for 90% of water use at ORNL. To date, 17 of these 33 facilities have been metered, and in FY 2013 more meters were procured that will be installed at 5 heavy-use facilities. Additional water meters have been purchased and installed at other locations throughout the complex.

Finally, ORNL commissions an annual water audit performed by an independent team. Findings and suggestions from each audit are integrated with ORNL's annual planning. ORNL received a 2013 Federal Energy and Water Management Award.

4.1.2 Plans and Projected Performance

Modernization activities that include both elimination of older facilities and addition of newer, more energy-efficient facilities must be considered if ORNL is to meet future WUI reduction goals. A facility disposition plan has been developed through FY 2020. Facilities totaling 127,359 ft^2 that use nearly 1.5 MGY are planned for demolition by the end of FY 2020. This activity is funded by the DOE Office of Environmental Management.

A strategic plan has been developed through FY 2020 to add new facilities to meet mission goals. Facilities totaling 76,815 ft^2 that

will use an estimated 76 MGY are planned for completion by the end of FY 2020.

Several water-saving initiatives are under way or planned through FY 2020 that are anticipated to save 11 MGY. Table 7 shows the anticipated WUI at ORNL through FY 2020, based on current assessments and the implementation of planned projects.

Figure 10 shows the Table 7 data graphically. The green horizontal line is the DOE FY 2020 WUI goal, the actual and projected data are shown in brown, and the annual DOE goals are graphed in red. The projection assumes that the project to eliminate OTC in Building 4508 and replace it with a closed-loop chilled-water loop will be completed and will save an estimated 80 to 100 MGY. Currently this project is scheduled for FY 2016, but it may be delayed due to funding constraints.

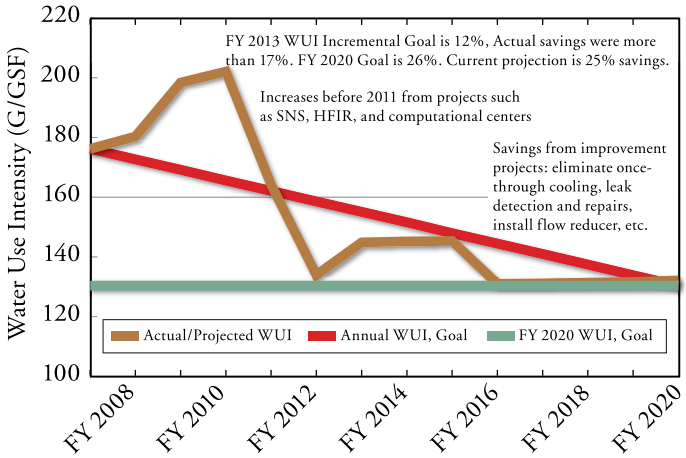


Figure 10. ORNL water use intensity (WUI) FY 2007–FY 2020, including 2020 and incremental DOE goals.

While both the table and figure show that we exceed WUI goals for the years from FY 2013 to FY 2020, with projected increases in water use we will need to identify additional water saving initiatives or risk slightly missing the final goal in the target year of FY 2020 (Figure 11).

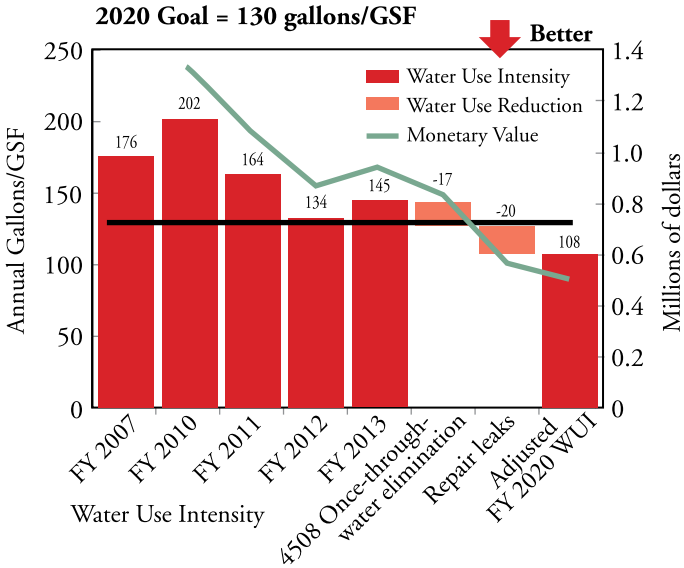


Figure 11. Water use intensity (WUI) reduction plan.
Note: ORNL HEMSF buildings have a high intensity WUI of 457 G/GSF. These facilities consume 45% of all water while covering only 15% of total building space.

Table 7. Actual and projected water use intensity estimates by year

Fiscal Year	Projected Area (GSF)	Projected Use (gallons)	Water Use Intensity (G/GSF)	Water Use Intensity Goals (G/GSF)
2007	4,975,592	876,814,000	176.2	176.2
2008	4,880,778	880,056,000	180.3	172.7
2009	5,021,366	996,171,000	198.4	169.2
2010	5,062,030	1,023,052,000	202.1	165.6
2011	5,420,439	890,477,000	164.3	162.1
2012	5,595,453	749,869,000	134.0	158.6
2013	5,586,804	809,583,000	144.9	155.1
2014	5,602,272	810,760,400	144.7	151.6
2015	5,594,621	810,481,400	144.9	148.0
2016	5,594,621	730,481,400	130.6	144.5
2017	5,591,834	730,828,600	130.7	141.0
2018	5,580,820	731,001,500	131.0	137.5
2019	5,573,758	731,158,300	131.2	133.9
2020	5,556,260	731,926,200	131.7	130.4

4.2 ILA Water Consumption

DOE Goal: 20% consumption reduction of industrial, landscaping, and agricultural water by FY 2020 from a FY 2010.

Industrial, landscaping, and agricultural (ILA) water is considered to be nonpotable freshwater used to aid processes such as cooling, washing, and manufacturing or for irrigation and other uses related to the production of agricultural products. Since 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.

The EPA Draft Guidance for EO 13514 water goals provides clarification of the proper categorization of various types of water usage. The guidance documents clarify that only nonpotable water should be included in the ILA goal, and potable water used for ILA should be reported in the potable water goal to avoid double counting.

4.2.1 Performance Status

Not applicable

Goal 5: Pollution Prevention and Waste Reduction

ORNL's pollution prevention (P2) program and supporting 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 measures; and to fully comply with state, federal, and DOE requirements concerning P2.

The P2 program and the plan, required by regulations, that documents 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 into our work controls for research and operational activities.
  - ALARA practices
  - Chemical hygiene
  - Work control procedures
  - National Environmental Policy Act (NEPA) project reviews
  - Each year, waste-generating divisions select one or two projects to implement that will address ORNL's identified targets and objects under the laboratory Environmental Management System. The divisions select a waste reduction, energy efficiency, or procurement project to implement during the course of the year. The projects are shared with other appropriate divisions and, in many cases, other DOE sites and DOE headquarters as P2 success stories.
- ORNL has taken steps to reduce the amount of material going to the landfill.
  - Development of contract language requiring construction contractors to recycle as much construction debris as possible, and report the recycled amounts, has resulted in significant amounts of material diverted from the landfill.
  - For routinely generated waste, it was determined that at least 30% of the material in the trash could have been recycled in established programs. To improve compliance with goals, employees have been issued recycling containers in offices and break rooms. Large recycling bins are provided in many areas, preventing common recycle materials from inadvertently being placed in the trash.
  - Recycle/reuse is maximized for both municipal solid waste (MSW) and construction and demolition (C&D) waste, including off-site recycling of broken furniture and public sale of polyurethane packing foam.

Based on these and many other efforts to divert MSW and C&D waste, in FY 2013 ORNL realized a 34% diversion rate for MSW and a 39% diversion rate for C&D waste.

5.1 Solid Waste Reductions (nonhazardous, other than construction waste)

DOE Goal: Divert at least 50% of nonhazardous solid waste, excluding C&D debris, by FY 2015.

Note: All 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 in the DOE CEDR are entered as "0" because the DOE Office of Environmental Management prime contractor counts all MSW for the entire ORO landfill

as Scope 1. ORNL is, however, responsible for the reduction of MSW, and the reporting in this section tracks goals progress toward DOE waste generation reduction.

5.1.1 Performance Status

As shown in Figure 12, ORNL's diversion rate for MSW in FY 2013 was 34%, as supported by data reported in CEDR. Although this is lower than the FY 2015 goal of 50%, ORNL has achieved a minor increase in diversion rate compared with the 33% realized in FY 2012 and the 26% realized in FY 2011.

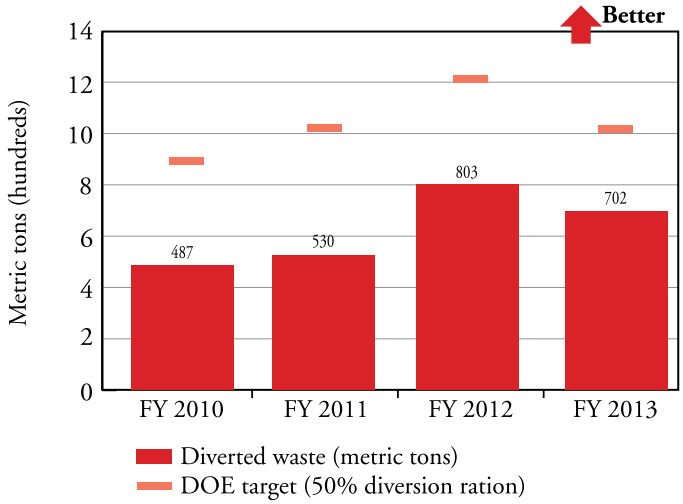


Figure 12. ORNL municipal waste diversion.

ORNL has continued its initiatives and best management practices to reduce the amount of material going to the landfill, including the following.

- Monitoring the materials going into trash cans and dumpsters to determine whether there are additional materials that have the potential for source reduction, recycling, or sale.
- Presenting findings of missed recycling opportunities to personnel to reinforce the mission of P2 (one venue was a laboratorywide seminar).
- Enhancing communication with divisions and facility managers concerning which materials are acceptable in the recycling streams (e.g., fiberboard, colored paper) and helping them find additional outlets for saleable and recyclable materials.

5.1.2 Plans and Projected Performance

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

- Monitoring the materials placed into trash cans and dumpsters.
- Presenting findings of missed recycling opportunities to personnel to reinforce the mission of P2.
- Enhancing communication with divisions and facility managers concerning which materials are acceptable in the recycling streams (e.g., fiberboard, colored paper).
- Reevaluating opportunities for composting by the ORNL cafeteria operator.
- Actively identifying and implementing options to reuse or recycle the waste ash generated by the new Biomass Steam Plant.
- Evaluating and implementing recycling of any new material streams identified (e.g., polystyrene packaging).

5.2 Construction and Demolition Materials and Debris

DOE Goal: Divert at least 50% of construction and demolition materials and debris by FY 2015.

5.2.1 Performance Status

ORNL's diversion rate for C&D debris (Figure 13) has consistently exceeded the 50% goal for a number of years, except FY 2013.

- FY 2010—85.6%
- FY 2011—61.9%
- FY 2012—78.6%
- FY 2013—38.5%

Supporting data were reported in the ORNL CEDR (tab 9.1c) submitted to DOE.

In recognition of cost savings opportunities, certain wastes were disposed 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 offsite for costly disposal as low-level radioactive waste. This effort allowed ORNL to determine that these wastes could be sent to the on-site landfills, which reduced waste management costs but also prevented the laboratory diversion rate from being even higher this year.

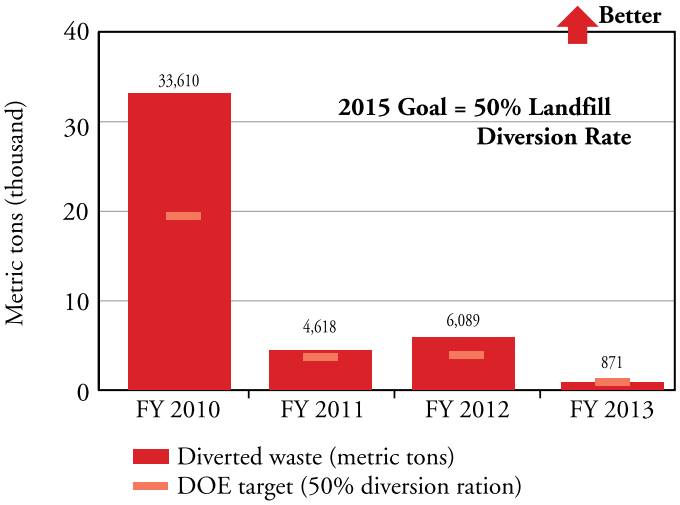


Figure 13. ORNL construction and demolition waste diversion.

5.2.2 Plans and Projected Performance

ORNL continues to pursue efforts to divert C&D wastes, including the following.

- Effective contract language has been developed that requires construction contractors to recycle as much C&D debris as possible and 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 internal remodeling debris from existing facilities. A vendor and storage location are used for recycling wallboard, rubble, wood, ceiling tiles, and metal. The collection of remodeling debris will continue and expand across the facility.
- There are internal NEPA reviews for most projects performed at ORNL. The P2 program has the opportunity to provide input. These reviews promote discussion with project engineers to plan for the reuse of soil, concrete, asphalt, and other C&D materials.
- Project managers and engineers ensure cost-effective diversion is included in project planning.

5.3 Additional Qualitative Components within Goal 5

In addition to the quantitative components discussed in Sections 5.1 and 5.2, Goal 5 includes qualitative components. These qualitative components address a variety of areas, including the anticipated impact of population change; continuing construction, decontamination, and decommissioning activities; and changing laboratory research initiatives and priorities. These variables will continue to have a strong impact on recycling and waste generation rates and volumes. These and other elements, such as the following, will continue to be addressed.

- Waste generation is intimately associated with numbers of personnel and funding levels. Waste generation can also fluctuate with changes in research and development missions. For example, ORNL saw record amounts of waste generation in FY 2010 and FY 2011 associated with American Recovery and Reinvestment Act funding that supported the demolition of several buildings.
- ORNL continues to experience an increase in retirees due to incentive programs, resulting in the one-time generation of waste from office cleanout by the retirees.
- To address ever-changing needs, ORNL has focused on putting systems in place to promote sustainability. The integration of sustainable operations is addressed in the Laboratory Agenda, budget planning guidance, internal procedures, and procurement evaluations. ORNL will continue to look for focused opportunities for waste stream reductions but will also concentrate on the more sustainable practice of source elimination.
- ORNL does not currently have a waste-to-energy system. Organizations that invest in these systems often improve their sustainable operation goals.
- With regard to printer and paper management, the Information Technologies Services Division (ITSD) completed a thorough evaluation of division printer costs and use that included the numbers and models of printers and toner cartridges, as well as paper use. ITSD piloted a networked printer, toner use, and paper management project in FY 2011. It was found to be cost-effective, and ORNL is expanding networked printer use. In FY 2013, the network printer contract was signed, and ORNL began setting up the servers, loading software, and testing the first set of standard printers. ORNL has started conducting printer assessments in a couple of buildings and organizations. In FY 2014, all of the requirements will be made final before the program expands across the Lab. ORNL's use of recycled content paper still has room for improvement. The P2 program will continue to work with buyers and Procurement to improve this performance.
- ORNL is increasing the use of acceptable nontoxic or less-toxic alternative chemicals and processes while minimizing the acquisition of hazardous chemicals and materials. An operational assessment of chemicals reviewed the acquisition, distribution, storage, use, and reallocation and disposition. The new Chemical and Materials Science Building (Building 4100) was designed to facilitate optimal chemical inventory management, chemical use, and sharing. The Chemical Management Center promotes the transfer of excess materials to new users, and the procurement pathway is designed to promote internal acquisition/exchange before purchase.
- ORNL implemented an integrated pest management (IPM) program that includes both interior and exterior strategies for the entire Oak Ridge Reservation (ORR). Practices include environmental controls such as ensuring 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.
- ORNL P2 staff participated in a team review of site property management procedures. As a result, ORNL has increased staff awareness of what materials can be sold and has expedited the process of reducing the amounts of materials subject to both recycling and waste deposition.
- The ORNL P2 program continues to prioritize minimization of the generation of waste and pollutants through source reduction. Avoiding waste generation will be given precedence over recycling or reuse even if it appears to be a detriment to recycling/diversion goals. For example, last year ORNL eliminated the purchase of bottled water except for instances in which staff members do not have access to plumbed water. This effort ultimately reduced the amount of recycled plastic water bottles. The avoidance of generating plastic bottles is the preferred outcome from both a waste and a cost perspective.

Goal 6: Sustainable Acquisition

6.1 Sustainable Acquisitions and Procurements

DOE Goal: Procurements meet requirements by including necessary provisions and clauses (Sustainable Procurements/ Biobased Procurements).

6.1.1 Performance Status

ORNL has made significant progress in its efforts to ensure that 95% of all new contracts, including nonexempt contract modifications, require products and services that are energy-efficient, water-efficient, biobased, environmentally preferable, non-ozone-depleting, and nontoxic or less-toxic alternatives and contain recycled content.

Supporting tasks completed toward this goal include the following.

- Standard contract terms and conditions, which are made part of all procurement actions for commercial items and services, invoke the pertinent Federal Acquisition Regulation (FAR) contractual requirements for energy, efficiency, and sustainability. Those clauses were included in 100% of the following FY 2013 subcontract actions:
  - 25,028 subcontracts, purchase orders, and task orders
  - More than 57,000 purchases against blanket ordering agreements
- Subcontracts that do not incorporate the standard terms and conditions that contain the clauses above are real property lease agreements, government transfers, and memorandum purchase orders with other management and operating contractors.
- Procurements made using an authorized purchasing card (P-Card) do not carry any provisions related to sustainable acquisition. During FY 2013 there were 33,299 P-Card transactions.
- UT-Battelle's Contracts Division has established an electronic file initiative, converting all active hardcopy subcontracts to an electronic database. All new subcontracts awarded after October 1, 2012, have been maintained electronically, which is 3 years ahead of the ORNL sustainability target date and represents estimated cost savings in excess of $222,610 annually.

6.1.2 Plans and Projected Performance

ORNL will continue to include clauses and provisions that stipulate environmentally preferable purchasing requirements in the majority of issued purchase orders, subcontracts, and task order actions. All material releases against blanket ordering agreements will also continue to be governed by the provisions included in the standard terms and conditions.

Goal 7: Electronic Stewardship and Data Centers

7.1 Meters for the Measurement of Power Utilization Effectiveness (PUE)

DOE Goal: All data centers are metered to measure a monthly PUE of 100% by FY 2015 (FY 2013 target: 80%).

Performance Status

ORNL continues to look for ways to reduce energy use, maximize efficiency, and minimize the cost of operations in our data centers. As the data centers grow to remain at the leading edge of computing technologies, sustainability efforts have helped to dramatically reduce the energy footprint required to perform great science.

1. **Electrical:** ORNL continues to use power strips that capture amperage, humidity, and temperature. In the Computational Science Building Annex, CSBX, the lighting control system is operating as desired. ORNL has also shifted 8–9 MW of load from one feeder onto another. This shift reduced the losses in the 13.8 kV feeder by about 1,472 MWh/year. Past electrical efficiency considerations include the following.
   - Locating large step-down transformers that supply 480 Vac directly to the computers as close to the units as possible to minimize the portion of the load that requires redundant uninterruptible power supply (UPS) backup
   - The use of high-efficiency UPS systems
2. **Mechanical chiller plant:** ORNL continues to improve chiller operations to maximize system efficiency, reliability, and resiliency. ORNL strongly intends to implement a method of optimizing control schemes for the chilled and condenser water systems by running the right equipment in the right way. Variable-frequency drives (VFDs) were added to condenser

water pumps, and flow limiters were added to cooling towers to optimize flow to the cooling towers. A VFD has been added to one of the ORNL 1,200 ton chillers. The plant controls will be optimized soon to maximize the benefit from this drive. Past chiller plant improvements include the following.

- Converted plant from primary/secondary to variable/primary.
- Chilled water pumps and cooling tower fans have VFDs.
- Maintained the lowest possible condenser water temperature.
- Installed flow limiters to increase the temperature difference on chillers.

3. **Mechanical data center:** ORNL's data center air flow management continues to improve. The CSBX data center uses cold aisle containment systems (CACS) with in-row coolers. This method of cooling minimizes fan energy, allows increased supply air temperatures, and increases the return air temperatures. Rack density in this data center is expected to be 220% more than in its predecessor. This consolidation process is saving costly facility square footage. The in-row coolers are expected to save 53% of the fan energy as well, compared with our baseline. Operationally, outages can be handled on a CACS-by-CACS basis, limiting the number of data center customers affected by an outage. Environmental conditions within each CACS can be set based on the needs of the individual CACS rather than on the needs of the entire data center. ORNL plans to implement reliability improvements that will also impact the energy consumption in the data centers. This effort will consist of adding logic to the BAS so that it alarms on conditions reflecting the performance of the cooling equipment. New systems control humidity based on dewpoint, and the units are networked so they do not fight one another. Relative humidity ranges have been expanded to the extent recommended by ASHRAE in CSBX. Past air flow improvements include the following.

- All data centers are arranged into hot and cold aisles.
- Floor penetrations outside the cold aisles are sealed.
- Cabinets with good internal air flow are used.
- Blanking panels are used in racks.
- Perimeter Computer Room Units (CRU) use supply air controls where possible.
- Cold aisle containment continues to be implemented in the Computational Science Building (CSB) E102 where possible and is the standard in CSBX.
- Electronically commutated fans or VFDs are used in all data center air handlers.
- CRUs are put in standby rotation where N+1 is available, with the standby unit automatically started if needed.
- Centralized humidity sensors were added to limit CRUs fighting one another while trying to control humidity.
- Night setback is implemented on the pressurization and fresh air supply in all data centers.
- Reheat was disabled in variable-air-volume boxes supplying the data centers.
- CRU sensors were calibrated and password protection enabled to restrict set point changes.
- Filtering was reduced on CRUs to reduce pressure drop.
- Where applicable, back flow dampers were added to prevent air from short-circuiting in data centers with perimeter-based cooling.

Plans and Projected Performance

Electrical

For all new installations, metered power strips are part of the standard installation, and all current equipment is being retrofitted with the standard meters as budget allows. This is an educational effort, as it gives the research community insight into the energy consumption of their systems, and the data gathered are readily available.

Mechanical

Planning is under way to allow for increased chilled water supply temperatures for future high performance computing (HPC) systems, an advance that holds the potential for significant energy savings. As part of the Reliability and Maintainability Program's continuous improvement agenda, plans are to hold equipment performance optimization sessions to identify performance indicators and alarm thresholds that can be implemented immediately, as well as indicators that are desired. This effort is to improve reliability, but it will also impact the efficiency of the operating systems. Inside the data center, we plan to methodically increase the supply air temperatures in one area of CSB now that most of the CACS are in place. We will also implement performance indicators to bring potential issues to light as early as possible.

7.2 Annual Weighted Power Utilization Effectiveness Goals

DOE Goal: Maximum annual weighted average PUE of 1.4 by FY 2015 (2014 target: 1.5).

Performance Status

ORNL has been metering power usage at most of its facilities over the past few years. During July 2009, the calculated PUE for both data centers averaged 1.336. Since that time, cooling, electrical distribution, and power metering improvements have been implemented. In reference to Tab 5.1 from the submitted ORNL CEDR spreadsheet, the calculated PUE value at the end of FY 2013 is calculated as 1.29 for the MRF data center and 1.26 for CSB. We anticipate that an automated real-time PUE calculation for all data centers will be in place in FY 2014. With improvements in the data center metering program, our ability to provide monthly and annual PUE calculations will continue to progress toward the FY 2015 goals.

Chilled water is supplied for HVAC systems and data centers from several chiller plants. Accurate PUE calculation, therefore, requires metering of water flow and temperature at several different locations to determine cooling. Installation of several Btu meters has been completed. The latest Btu meters to be installed are expected to come online in early 2014. Further integration of our BAS and Central Energy Data System (CEDS) will be required to calculate proportions of flow, a measurement required for a more accurate PUE calculation.

As power meters exist in each chiller plant, power per ton-hour or chiller plant efficiency is known. Monthly and yearly totals have been added to the BAS for easy analysis of long-term trends. This can be factored into PUE calculations after installation of the last Btu meters and measurement of the ton-hours from each plant contributing to data center cooling.

Plans and Projected Performance

Plans for FY 2014 are to address longer-term solutions, including the following considerations in reference to servers and equipment. The selection of equipment used within a data center is crucial to the level of energy consumption at a location. The changes that can be made to reduce energy consumption range from purchasing the most efficient and modern equipment to simply configuring existing equipment differently within the data center. Thus a comprehensive knowledge of best practices, encompassing policies and technologies, is the best means of reducing data center energy use. ORNL proposes to study and implement best practices as they relate to servers and associated equipment. Most of the existing IT equipment in the data center with the worst PUE is continuing to be consolidated into a new data center that has implemented the industry best practices to date. This effort will improve ORNL's average PUE. Previous recorded PUE data suggest ORNL is already ahead of the PUE goal for 2015, but ORNL has internal goals to continuously improve PUE. Currently, ORNL is striving to obtain PUEs for its future HPC systems in the lower end of the 0.1–0.2 range. Current upgrades to the HPC systems have greatly improved the amount of computing done per kilowatt (increasing it by 3–4 times).

Potential savings identified by project are listed in Table 8.

Storage Devices

- Storage redundancy needs to be rationalized and right-sized to avoid rapid scale-up in size and power consumption.
- Consolidating storage drives into network-attached storage or a storage area network are options that take data that does not need to be readily accessed and transport it offline.
  - This lowers the storage and CPU requirements on the servers
  - It corresponds directly to lower cooling and power needs in the data center
  - For data that cannot be taken offline, the recommendation is to upgrade from traditional storage methods to thin provisioning.
  - Cloud storage and maximization are being considered.
- Dependent upon funding
  - Use computer systems that have even lower unit energy consumption and that are designed to operate at higher chilled water temperatures and higher air temperatures
  - Pursue long-term plans to continually optimize system performance

An identified barrier to improving ORNL's PUE is getting funding for lake water cooling. This will be critical for future HPC systems to be brought online in the coming years.

7.3 Electronic Stewardship

DOE Goal: 100% of eligible equipment with power management actively implemented and in use by FY 2012.

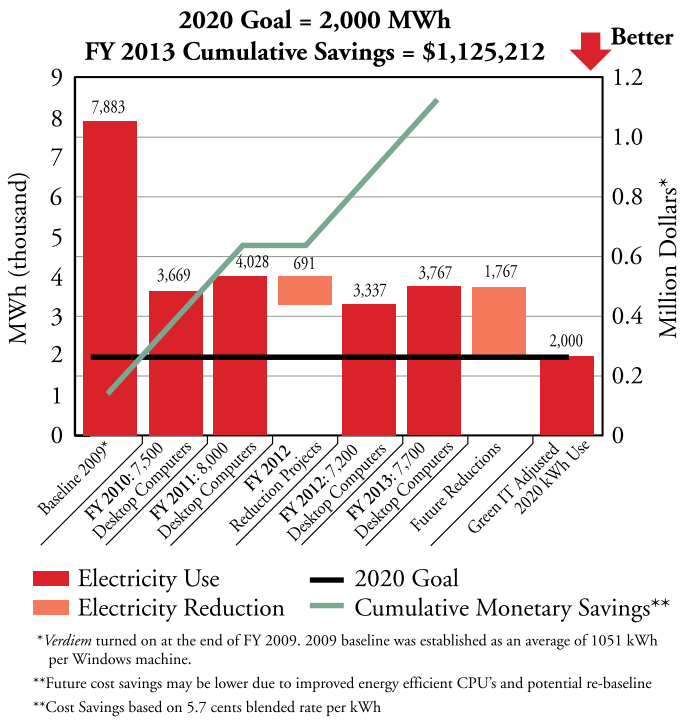
7.3.1 Performance Status

ORNL continues to successfully meet the electronic stewardship goal of power managing 100% of the eligible personal computers, laptop computers, and monitors in use by laboratory staff. The progression of electronic stewardship and electricity savings is shown in Figure 14. Power management capabilities are among the requirements specified during the requisition and purchase of standard computer hardware, and power for on-site equipment is controlled by Verdiem Surveyor software during times of employee inactivity for all compatible hardware. As a result of an IT resource

Table 8. Potential savings identified by project

Project Description	Savings
Reduced quantity and size of equipment for reduced storage tank capacity	$64,500
Optimized chilled water system control	3,816,000 kWh and 2,223,000 gallons of water
Higher chilled water temperature	14,700,000 kWh
Data center air management	60,000 kWh per year

conflict, the Verdiem Surveyor software was not upgraded in production to the newest platform during FY 2013; however, testing has continued for many of the system's newest features. In addition to security enhancements and an improved reporting platform, the Verdiem upgrade would provide added technical capabilities for the power management support of Macintosh computers and laptops.



Verdiem turned on at the end of FY 2009. 2009 baseline was established as an average of 1051 kWh per Windows machine.

**Future cost savings may be lower due to improved energy efficient CPU's and potential re-baseline

**Cost Savings based on 5.7 cents blended rate per kWh

Figure 14. ORNL electronic stewardship and electricity savings.

The Green IT initiative first piloted the Verdiem Surveyor product in 2009. ORNL has cumulatively saved more than $1 million in energy cost avoidances since the 2009 product inception.

A shared services contract for printers was awarded in August 2013, and ORNL is in the initial stages of planning and assessment to deploy network printers across the laboratory. The printer contract will help ORNL standardize equipment, reduce energy consumption and landfill waste, reduce cost of operations, improve printing services in general, and provide more efficient use of consumable products such as paper and toner. The goal of the printer shared services project is to assess each division at the laboratory to promote the use of fewer local desktop printers and more network printers, thereby shrinking the printer equipment footprint and saving essential overhead costs by limiting toner purchases, support costs, and power demands.

ORNL continues to move forward with implementation of desktop, application, and server virtualization technologies. A virtual desktop pilot is in progress within the Business Services division, using "zero clients" as a replacement for personal computers (a zero client is a more secure version of a thin client and is more energy efficient than a computer in sleep mode). A pilot of about 50 Business Services users and 50 IT users is currently under way. The Information Technology Division at ORNL hopes to transition the entire Business Services Directorate and more than 100 ORNL public conference rooms from traditional computers to zero clients before expanding the zero client offering to other directorates in FY 2014. The IT enterprise infrastructure continues to move toward virtual servers as systems are refreshed. Current data show that 85% of the servers supporting the enterprise are no longer on stand-alone hardware but are on one of several virtual hosts. All servers moved into the new data center are considered for virtualization, keeping the footprint of the server room small while still meeting performance needs for users.

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

- ORNL IT offers standard computer hardware through three vendors on Marketplace. The vendors are required to sell only Electronic Product Environmental Assessment Tool–certified computers, monitors, and laptops.
- All desktop and laptop computers (Windows, Macintosh, and Linux) have an initial screen saver setting of 15 min. Users are encouraged to keep the screensaver set to 15 min or less.
- All Windows desktops are required to be power managed. The Verdiem service collects power use data on all laptops but is not used for managing power. Laptop power management is performed within the operating system by the user. Devices registered as instruments or servers are excluded from power management.
- Where possible, duplex printing is set as default on all print queues managed by ORNL IT.

7.3.2 Plans and Projected Performance

ORNL's Green IT sustainable campus roadmap for FY 2014 includes the following.

- Assessment and implementation of shared printer services across the laboratory.
- Initiation of a user education campaign that focuses on minimizing local desktop printing and encourages greater use of ORNL network printing.
- Completion and rollout of Verdiem 6.0 to support Macintosh power management and improved laptop provisioning.
- Expanded use of zero client computers and virtual desktops to take advantage of lower energy consumption, application virtualization, and data centralization to reduce single user use of multiple computers.

While ORNL expects to remain fully compliant with the electronic stewardship goal (power manage 100% of eligible equipment), it is possible that restricted budgets could interfere with the necessary labor, materials, and/or software needed to achieve sustainability goals.

Goal 8: Renewable Energy

8.1 Renewable Energy Performance

DOE Goal: 20% of annual electricity consumption from renewable sources by FY 2020 and thereafter (FY 2013 Goal: 7.5%).

ORNL plans and actions are moving toward achievement of the DOE goals of providing 7.5% of the site's electrical consumption from renewable sources for FY 2013 and 20% by FY 2020 and thereafter. Until recently, renewable energy (RE) generation at the laboratory was primarily through small research-oriented PV systems. A 5 kW PV array was brought online in early FY 2008, and a 50 kW PV array began providing electricity in FY 2009. The new 47 kW PV array for the parking canopy went online in FY 2011 and can also be used to offset the power used for 25 EV charging stations. A smaller rooftop PV array (30 kW) also contributes to ORNL's on-site generation capabilities (Building 4100 rooftop installation).

8.1.1 Performance Status

Currently, ORNL has identified multiple sources of RE to offset an electrical consumption of 574,485 MWh, including the following.

- The electricity produced on-site from the four solar arrays accounts for about 0.024% of ORNL's electricity, including the on-site double bonus generation.
- ORNL participates in the TVA Green Power Switch Program, purchasing 337.5 MWh of RE (0.06%) through the first half of FY 2013, continuing the 10-year partnership as TVA's first industrial participant. ORNL also received a gift of 1.5 MWh for a green Earth Day celebration from the TVA Green Power Switch Program.
- ORNL also participates in the new TVA Southeastern REC pilot program, purchasing 3,000 MWh of RECs during the second half of FY 2013.
- ORNL purchased an additional 53,948 MWh of RECs from wind resources (9.39%).
- The total RE of 57,558 MWh exceeds the 7.5% FY 2013 goal at 10.02%.

As an additional benefit of meeting the RE goals, energy generated from approved renewable means, either on-site or purchased from off-site vendors, can be allocated to new or significantly renovated buildings to assist in achieving LEED certifications for the rating desired. This will ensure that new buildings/renovations will have their dedicated renewable resource in case FY 2014 funding is limited and would not permit a laboratorywide REC purchase.

8.1.2 Plans and Projected Performance

Due to the high cost of on-site RE projects, the search for renewable production is challenging. In light of this, we have mapped the following strategy.

- RECs—ORNL will periodically monitor the REC open market and consider purchases if they are required to meet the renewable goal.
  - ORNL may use multiple purchases throughout the year based on energy consumption projections and REC pricing to allow strategic purchasing of RECs to best fit the 7.5% goal for FY 2014 and the increase to 20% by FY 2020.
  - 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.
- SMR—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, ORO, and/or ORNL.

Goal 9: Climate Change Adaptation

DOE Goal: Improve understanding of climate change effects and impacts and improve understanding of climate change vulnerabilities and risk.

Performance Status

ORNL has reviewed the April 2012 report DOE High Level Analysis of Vulnerability to Climate Change by means of the Guidance for FY 2014 DOE Site Sustainability Plans (August 2013). Operations personnel have not been notified of any change in mandatory reporting or of any new DOE orders to address this directive. ORNL is located in East Tennessee, in a temperate, noncoastal geo-

graphic area where the mountain and ridge systems protect it from major weather events such as hurricanes or widespread flooding. TVA maintains a complex and effective system of dams and local flood control structures that further protect local infrastructure. ORNL is involved in several climate change and adaptation research projects. A recent report produced by ORNL, *The State of the Future for a Sustainable Tennessee: Grand Challenges and Grand Opportunities Under a Changing Climate,* summarizes key climate change issues and opportunities in Tennessee. In addition, ORNL is home to the Climate Change Science Institute (CCSI), an interdisciplinary, cross-directorate research organization created in 2009 to advance climate change science research. Over 100 researchers from the Computing and Computational Sciences Directorate and the Energy and Environmental Sciences Directorate form CCSI. Research programs are organized across the following four themes.

- Earth System Modeling
- Data Integration, Dissemination, and Informatics
- Terrestrial Ecosystem and Carbon Cycle Science
- Impacts, Adaptation, and Vulnerability Science

This integration of staff across directorates merges computational scientists and modelers with environmental field researchers and data specialists to execute large-scale, model-driven field research. Outcomes from modeling efforts and field research can link directly with research in the Impacts, Adaptation, and Vulnerability Science theme. This research integration approach has been successful in executing projects such as SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental Change), NGEE (Next-Generation Ecosystem Experiments)-Arctic, and PiTS (Partitioning in Trees and Soil).

ORNL is also involved with information sharing with other agencies on the subject of climate change. This has been done mainly through the Southern Appalachian Man and the Biosphere (SAMAB) association. Agencies involved with SAMAB include the EPA, US Forest Service, US Fish and Wildlife Service, US Geological Survey, US National Park Service, Great Smoky Mountains National Park, and North Carolina Department of Environment and Natural Resources.

Climate Change Adaptation Research and Technical Assistance at ORNL

ORNL is a globally recognized center of expertise in climate change adaptation research. It is leading two chapters of the Intergovernmental Panel on Climate Change Fifth Assessment Report related to adaptation, and it is playing leadership roles in the US National Climate Assessment related to energy supply and use, connected built infrastructures, scenarios, and indicators. ORNL is funded by the DOE Office of Science to incorporate adaptation of integrated assessment research tools and applications, which will become a new DOE Science Focus Area for ORNL in FY 2014. Other support for climate change adaptation research in recent years has come from the National Oceanic and Atmospheric Administration, the US Department of Defense, the US Department of Homeland Security, the government of Australia, the private sector, and the Laboratory Directed Research and Development program. To support regional cooperation, in August 2012—in collaboration with Sustainable Tennessee—ORNL produced the report *The State of the Future for a Sustainable Tennessee: Grand Challenges and Grand Opportunities Under a Changing Climate* (http://sustainabletennessee.org/wp-content/uploads/2012/09/Sustainable_TN.pdf).

Plans and Projected Performance

ORNL plans to discuss the feasibility (including costs) of conducting a high-level assessment/analysis of potential major site-specific/local vulnerabilities to climate change during FY 2014. Any development of potential climate change adaptation plans or vulnerability assessments will be best addressed as part of any new requirements issued by the DOE Sustainability Performance Office and/or the Office of Science.

In addition, updates to ORNL's emergency response plans can provide an effective way to promote adaptation to potential climate change events such as the increase in intensity and frequency of major weather events. The office of the Laboratory Shift Superintendent (LSS) and its supporting information center is the primary means of conveying emergency information to staff and surrounding first-response organizations. During an emergency, LSS often becomes ORNL's Emergency Response Center and coordinates both internal and external communications and manages activities designed to manage risk and minimize losses. Several Standards-Based Management System procedures cover LSS and the laboratory's emergency response operations.

III Oak Ridge National Laboratory Right-Sizing of Fleet Management Plan

In support of Secretary Chu's fleet reduction initiative, the Oak Ridge National Laboratory (ORNL) reduced its fleet by 58 vehicles in FY 2012. This is a 52% reduction in our General Purpose and Administrative vehicles from our 2005 baseline. The remaining 439 ORNL fleet vehicles are assigned to functions that cannot withstand additional reductions without impacting critical mission elements or the ability to provide for a safe, secure, and environmentally sound work environment on a 50 square mile site with more than 4,500 employees.

See Appendix B for complete information on right-sizing the ORNL vehicle fleet

IV Site Innovation

The goal for innovation at ORNL is to help DOE maintain US global leadership in science, engineering, and energy management. ORNL will continue to research, develop, demonstrate, and deploy innovative solutions and initiatives to advance sustainability. Many of these developments will be deployed at ORNL to advance sustainability on the campus and, in parallel, share successes and demonstrate transportability. ORNL's diverse operations and research staff members are dedicated to achieving these goals, supporting a large number of innovative projects and initiatives. ORNL is well positioned to demonstrate leadership in science, engineering, and energy management and to further advance sustainability in federal operations and scientific research.

Projects in the area of sustainability are considered based on feasibility, cost, and potential impact. For those considered feasible, commensurate with other goals, and potentially affordable, multiple funding mechanisms are considered, including DOE support, laboratory funding, and various forms of third party engagement.

The following are among the projects recently considered or still undergoing evaluation.

1. Support for TVA's development of an SMR for dramatically reducing GHG emissions and paving the way for broader national use of this technology. ORNL plans, with DOE support, to assist TVA in the development of a 150 MW (minimum) capacity SMR. This is expected to take the form of a DOE power purchase agreement as security for a TVA-industry consortium investment. DOE has agreed to fund design and engineering costs for this project, with a location in Tennessee. ORNL and the department estimate that operation of such a reactor will yield a 550,000 $MTCO_2e$ per year reduction in GHG emissions for the laboratory, satisfying an estimated 43% of DOE's Scope 1 and 2 reduction goals for FY 2020.
2. Development of plug-in EV (PEV) solutions for sustainability. A team at ORNL is working with collaborators from industry, universities, and electric utilities to develop PEV charging

stations with a technology known as wireless power transfer (WPT), charging vehicles without the need for cables and plugs while the vehicles are stationary, in stop-and-go mode, or even while in motion. Once implemented, WPT will enable smaller, lighter batteries, lowering the cost and weight of electric vehicles and increasing their efficiency and reliability. Combined with wireless communications, a truly autonomous charging technology can be deployed that removes the vehicle operator from the loop. The technology will also enable future innovations such as automatic positioning, obstacle detection, utility time of use and rate structures, and other convenience features that are only beginning to surface. Solutions such as the WPT technology can truly transform sustainable transportation by making the use of PEVs as acceptable and dependable as gasoline-powered vehicles were in the last century.

3. Installation of EV charging stations to introduce and advance acceptance of highway-ready EVs and demonstrate the use of renewable power, external battery storage, EVs, and the power grid all working together for maximum efficiency. ORNL has installed 25 solar-assisted EV charging stations and 19 non-solar-assisted charging stations including one DC fast charger. Thirty employees have acquired PEVs (Nissan Leafs, Chevy Volts, Ford C-Max, and Prius) and regularly charge them on campus during work hours. DOE has approved, during the research period ending September 2014, free charging for EV drivers. Research data are being collected and will be published for agency and public benefit.
4. Development of CEDS to collect, analyze, and access real-time energy data for the entire campus. In FY 2013 CEDS grew to include 600 smart meters configured and reporting consumable utility data to the system. These consumption meters collect data on electric power, water, steam, and electric vehicles, contributing to the laboratory's smart grid and energy management capabilities. In addition, an integrated CEDS EnergyCap module has been deployed to facilitate additional electrical consumption monitoring and reporting capabilities. CEDS training, which allows access to CEDS data and the ability to view real-time, trend, and historical data, was provided for facility managers, complex managers, utility engineers, and research staff. CEDS can be readily transported to other settings.
5. Pursuit of small pumped storage for reducing peak power demand. To pursue this opportunity, ORNL is investigating the business case for installing a pumped storage facility. For every 2 MW of peak power reduction, ORNL can save $370,000 per year. To pursue this opportunity, ORNL is investigating the possibility of installing a pumped storage facility. The ORNL site has considerable topographic relief (~600 ft) and a TVA dam/reservoir adjacent to the site. These factors favor the possibility of using small pumped storage to offset the typical afternoon peaks in power demand. Given that peaking power is a national grid issue, if this approach is proven cost-effective, ORNL can pave the way for deploying this technology in municipal, military, university, and industrial settings across the nation.
6. Green gas generation as an option for renewable resource use. Green gas is renewable (landfill) gas that is injected into a pipeline near the point of generation and accounted for at that point. ORNL can purchase credits, burn an equivalent quantity of natural gas, and claim it as a renewable resource. We would use the green gas to drive a reciprocating engine and electrical generator. This project is now well defined and is ready for presentation of the business case and for seeking funding.
7. Maximize cost-effective energy efficiency in buildings for the advancement of energy efficiency and renewable power use in buildings. ORNL has a net-zero energy building on campus (Building 3156) that has seen a 40% reduction in energy demand coupled with 67.7 MWh/year of solar-generated power. Going forward, ORNL will focus on LEED for existing buildings, HPSBs, and renewable power generation. This will provide experience on getting existing buildings to high performance standards while advancing renewable energy strategies.
8. Demonstrate world-class efficiency in research supercomputing. OLCF continues to make preparations for the delivery of its next HPC system. This computer, slated for deployment in 2017, will make significant additional power, space, and cooling demands. To accommodate these demands, OLCF is securing additional space through the build out of more than 10,000 ft^2 in the CSBX and is planning to deliver more than 20 MW of additional electrical distribution capacity. OLCF has already completed initial plans for the facility build out that leverage emerging ASHRAE technical committee standards and guidelines for energy efficiency and incorporate energy-saving design features including warm-water cooling of the HPC system, blending of multiple water temperatures, and water-side economizers.

In addition to these transportable sustainability projects, ORNL is committed to programs that enhance the physical environment and touch the daily lives of employees and members of the larger community for the better. Important examples include continuing efforts to promote employee health and wellness and the demonstration of sustainable landscaping, a daily reminder of the benefits of sustainable solutions for all employees and visitors to see.

Employee Wellness Program

ORNL's award winning Wellness Program is an example of the commitment to its most valuable resource, people. With an emphasis on prevention and employee involvement, the program offers free

- health assessments;
- consultations with ORNL's registered dietitian and exercise physiologist;
- health seminars and screenings;
- access to an on-site physical therapist;
- fitness assessments;
- fitness centers, available 24/7; and
- walking, jogging, and exercise programs.

To encourage employees to take an active part in improving their health, ORNL offers an incentive program through which they can earn a $30 per month reduction in ORNL medical plan premiums. Following are some of the special events sponsored by the program during the past year.

- The annual ORNL Benefits and Wellness Fair (cosponsored with the ORNL Benefits group). One of the highlights of the health and fitness year, the fair introduces employees to various health and fitness vendors (typically about 100) from the surrounding community who provide educational materials, conduct screenings (including mammograms, bone density, and blood sugar), and provide related information and services for ORNL employees.
- May HealthFest. In honor of National Employee Health and Fitness Day (the third Wednesday in May), the ORNL Wellness Program has turned the entire month of May into HealthFest, providing about 30 events and activities throughout the month including a 10K, line and swing dance sessions, hikes, yoga, pilates, fitness walks, bike rides, fitness challenges, lectures, belly dancing—virtually something for everyone.
- Santaclaustrophobia Challenge. An annual favorite, the program challenges participants to gain less than 2 pounds over the holiday season. Participation in November–December 2012 increased 86% to 880 employees, and roughly 80% met the challenge and kept their weight down to less than a 2-pound gain. After tallying all the gains and losses, the program netted 1,259 pounds of lost weight compared to 2011's 1,170 pounds.
- Biggest Loser Team Challenge. A 12-week weight management program, the Biggest Loser has been conducted three times at ORNL, with about 47 teams, comprising a total of 275 employees per challenge. Cumulative weight losses of 1 to 1.5 tons have been logged by program participants. The program is competitive fun, offering team awards, awards for all individuals losing 10% or more of their weight, and awards for the male and female biggest losers. A Biggest Loser maintenance group was run contiguously, with 84% of the group maintaining or losing weight during the 12 weeks.

Natural Resources Management and ORNL Landscaping

ORNL lies within a fairly undeveloped eastern deciduous forested area (part of the 33,500 acre ORR). Landscape planning at ORNL uses the surrounding healthy forest ecosystem as a model with the objective of increasing ecosystem services provided on-site through landscaping. Ecosystem services are identified using the Sustainable Sites Initiative definitions.

A primary FY 2013 action included identifying areas outside of the ORNL campus, but within the ORNL footprint, that are potential sustainable research and demonstration areas, possible mitigation areas, protected areas for sensitive habitat, vegetation restoration sites, and walking/biking path use areas. This information has been digitized and provided as input to the ORNL Campus Master Plan development. Other actions included developing a long-term vision and beginning to implement a maintenance plan for the ORNL Swan Pond, identifying potential sites for wetland enhancements that could be considered if mitigation is needed, outplanting of American chestnut seedlings, development of a plan for a pilot project for sustainable management of power line rights-of-way, and continuing invasive plant treatments on ORR.

ORNL manages the natural resources on the 33,500 acre ORR for DOE. The 2012 Forest Management Plan continues to be expanded and includes the following sustainable approaches.

- Development of integrated pest management plans for monitoring forest pests such as hemlock woolly adelgid, emerald ash borer, thousand canker disease, gypsy moth, etc., consideration of options, and prioritization of treatments
- Identification, enhancement, and protection of special plant and wildlife habitats such as migratory bird habitat, wetlands, and native grass/meadow communities
- Planning, prioritization, and treatment of invasive plant infestations
- Sequestering of carbon in forests and soils
- Development of best management practices that address ORR specific needs for ecologically sound road maintenance, tree salvage, culvert installation, and revegetation

During 2013 presentations were made to various community organizations, sharing the concepts and approaches for sustainable landscaping at ORNL.

FY 2014 ORNL landscaping goals include the following.

- Developing plans to reduce mowed areas
- Continuing to implement, assess, and modify Swan Pond maintenance practices
- Developing plans for enhancement of riparian areas along Southside Drive-White Oak Creek, if funds are identified
- Identifying wooded and forested areas to protect and enhance within the ORNL watershed

V Management and Funding

ORNL assesses 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, taking into consideration 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.

Performance Status

Large scale projects undergo a unique assessment. ORNL implements DOE O 413.3B, the requirements of which include analyses of alternatives, justification/strategic need, economic considerations, technical and operational considerations, environmental impact, energy conservation, sustainable design, waste minimization, value engineering, and risk assessment.

ORNL has deployed SCI, the goal of which is to achieve benchmark sustainability in campus operations and in the research, development, and deployment of key technologies. The time frame for SCI implementation is 10 years, with emphasis on near-term improvements. Funding determination for specific projects and actions under SCI assess the potential environmental, economic, and social benefits of each measure.

SCI currently has 26 dynamic roadmaps at varying stages of implementation. Each roadmap has specific fiscal year deliverables that are kept on schedule through regular review meetings held between individual roadmaps owners and the SCI leadership. In addition, the Facilities and Operations director, an SCI sponsor, has made success on these roadmaps a part of his department'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 to present 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. The majority of the projects considered as good candidates for ECMs have a financial payback estimate of less than 2 years. Cost and energy savings for completed and proposed ECMs are shown in Tables 9 and 10.

Plans and Projected Performance

ORNL will continue current practices to identify, assess, fund, and implement projects that are designed to address mission needs while advancing federal leadership in energy, environmental, and sustainability practices.

For major projects, thorough and multiple financial analyses will be conducted, including expected power production from the project vs expected purchased power cost, payback time on DOE investment, risk considerations, and net present value of various options.

Following is a description of business cases that have been developed or are in progress and their status, including resulting initiatives that have evolved from them.

- Early in FY 2012, ORNL compiled a business case demonstrating a DOE cost share whereby TVA would supply SMR power to ORNL and other ORO locations. The initial analysis consisted of an assessment of the economic viability and environmental benefit of construction and operation of a first-of-a-kind commercial SMR in the TVA region. The SMR project is intended to provide the means for addressing both energy independence and the potential for advanced deployment of carbon-free emissions.

  The analysis concluded that construction of an SMR would

  - allow the Office of Science to significantly reduce GHG emissions while allowing for vital mission growth;
  - allow DOE to meet a major portion of the departmentwide goal for GHG reductions;
  - provide ORNL with long-term stable and cost-competitive electricity for continued and expanded missions; and
  - pave the way for broad use of SMR technology, giving the nation another key tool for reducing its dependence on fossil fuels.

  In FY 2013, DOE agreed to provide funding support to a consortium consisting of TVA, Babcock & Wilcox, and Bechtel Corporation to test and evaluate a pilot design for the SMR and to seek regulatory approval. ORNL is prepared to support further analysis and planning for the SMR and any related alternatives as this project develops.

- In considering projects for the advancement of solar technology, relevant factors include the market value of RECs, the cost of solar power vs purchased power, and a comparison with other technologies available for meeting renewable energy goals. Funding alternatives include direct DOE investment, leasing facilities from an external party, and establishing a Power Purchase Agreement with an external party who would make the necessary investment. At this time, the relatively high cost and long-term payback associated with a large solar array (i.e., 1 MW or larger) are considered prohibitive in comparison to other renewable energy alternatives. ORNL will continue to implement and operate smaller solar units where feasible and to consider larger units and

projects as solar technology continues to progress.

- In FY 2012, a business case was completed for the procurement and operation of a 2 MW capacity natural gas internal combustion generator to produce electricity by burning landfill natural gas. The DOE O 430.2B goal of providing 7.5% of the site's electrical consumption from renewable energy sources is reduced by one-half if the electrical energy is generated on-site. It is therefore estimated that a 2 MW generator would address as much as 50% of this goal based on ORNL's projected future electricity use. This generating capacity also would allow ORNL to offset utility demand and energy cost, develop backup power capability for its HPC, and potentially provide waste heat to building hot water systems or for absorption cooling. In addition to procurement and installation, cost criteria evaluated included cost of capital, operating costs net of costs avoided by reducing power (and associated carbon emissions) from other sources, and cost and market value of RECs.

  Depending on availability and prioritization of funding, ORNL is currently considering incorporation of the 2 MW generator in the 7000 area revitalization plans. Installing the generator as the first phase of a 7000 area energy park could provide the following long-term benefits.

  - The generator would be a highly visible statement of DOE and ORNL's commitment to green energy.
  - Green gas electricity generation with combined heat and power would enable the demonstration of energy leadership by meeting a substantial portion of ORNL's renewable electricity mandate while limiting the purchase of RECs.
  - Waste heat recovery, along with an associated thermal energy park, potentially could provide building space heat in the winter and reheat or absorption cooling in the summer.
  - An energy park would provide additional opportunities for future development of a utility scale solar farm and renewable resource integration research.
  - A visitor center/control room at the facility could provide an energy showcase for public viewing of green energy generation and use.

- In FY 2012 and FY 2013, a business case was completed and refined for construction and operation of a new power substation near the east campus area of ORNL. The new substation will provide increased overall reliability and efficiency in distributing power to the diverse research and unique missions it will support. Rapidly escalating power requirements are a primary and immediate driver for the new substation. Major cost factors include design and construction, cost of capital, payback period, and evaluation of funding alternatives based on benefits to impacted programs. Cost savings should be realized from reduced line losses and potentially lower operations and maintenance cost due to transmission of power over shorter distances. Cost savings from reduction of transmission line loss is estimated to be roughly 0.75 MW, or about 3% of the FY 2016 projected load. Savings will increase as the load increases in the future.
- Early in FY 2013, a memorandum of agreement was developed between DOE, TVA, and ORNL whereby TVA will provide financing and perform construction of the new substation, and ORNL programs will repay over a preset term. Construction is currently under way, with expected completion and start-up in FY 2015.
- A business case study and analysis continues on altering ORNL's chilled water system for CSB. The study investigates efficiency, water use, and satisfying cooling requirements for the post-Titan generation of high performance computers (i.e., OLCF-4 in the 2015–2016 time frame and the exascale machine around 2020). Alternatives under study include the construction of a new traditional chilled water plant, construction of a lake water plant using natural chilled water from Melton Hill Lake, and a combination of the lake water plant and an existing ORNL chilled water plant. Advantages associated with using lake water for chilling include the following:
  - potentially large reductions in the amount of needed electricity (and associated reduction in carbon emissions),
  - potentially large reductions in the amount of purchased water,
  - potentially large reductions in the amount of chemicals and water used (i.e., blow-down discharged to creeks), and
  - potentially demonstrates use of a readily available renewable resource.
- Smaller strategic projects, such as employee engagement and waste reduction, are funded recognizing the impact on employee behavior, GHG emissions, and general sustainability of the campus. Other projects may be funded on a demonstration basis but always with a belief that they offer sufficient probability of success to warrant early support.

The major barrier to success for any of these projects often involves lack of available funding or conflicts in prioritization when balancing funding requirements for sustainability projects vs research and research support programs. This is particularly relevant considering current and evolving federal budget sequestration concerns. Other barriers include delays in final decision and approval by ORNL and DOE management due to the time required to fully analyze and resolve technical and funding issues and, in cases of third party involvement such as the east campus power substation, delays in obtaining and finalizing competitive and satisfactory terms for financing.

Regularly scheduled reviews with SCI sponsors and the ORNL SCI Leadership Team, discussed previously, are intended to maintain the proper focus to meet critical path project objectives while at the same time considering overall budget and funding positions.

Table 9. ECM projects, budget, and schedule

Potential Sustainability Projects	Project Cost ($K) through FY 2020	FY11	FY12	FY13	FY14
		Actual ($K)	Actual ($K)	Actual ($K)	Proposed & Funded ($K)
Behavioral Modification				$40	$25
Energy and Water Audit/Evaluations	$1,915	$200	$300	$215	$200
HPSB	$1,034	$100	$159	$125	$50
Building Envelope (1)	$300	$200	$100		
HVAC - controls and high efficiency equipment replacements (1)	$850	$600	$250		
Lighting - delamping and controls (1)	$350	$200	$150		
Plumbing - water saving fixtures (1)	$100	$50	$50		
Appliances - energy star and power strips (1)	$130	$80	$50		
Advanced Meter Installations - Electric (2)(3)	$572			$322	$250
Advanced Meter Installations - Steam (2)(3)	$523			$23	$250
Advanced Meter Installations - Natural Gas	$250				$100
Advanced Meter Installations - Chilled Water	$250				$100
Advanced Meter Installations - Potable Water	$125				$75
1060 - Ventilation Assessment (4)	$32			$32	
1505 - Occupancy Based Lighting Control	$26			$26	
1505 - Retrocommissioning	$156			$56	$50
3150 - DP Control of VFD	$3			$3	
4500N - Occupancy Based Lighting Control	$12			$12	
5200 - Lighting Control Upgrade	$71			$71	
5600 - Chiller VFD (1200 ton)	$200			$200	
5600/5700/5800 - Recommissioning	$169			$23	$146
1005 - Reducing Air Flow & HVAC scheduling	$43				$43
4500S - Reducing Air Flow in Unoccupied Space	$44				$44
4501/4505 - Resolving Steam Trap Issues	$46				$46
4508 - Optimizing High Bay Supply and Exhaust Air	$77				$77
5200 - Implement New HVAC Schedule w/ Occ. Ctrl.	$71				$71
5500 - Variable Flow and Unoccupied Mode for AJ-101	$53				$53
4515 - Retrocommissioning	$17				
5500 - Unoccupied Modes for SF-1 and SF-2	$37				
5510A - Make-up Air Unit and Exhaust Off at Night	$42				
Building Envelope Modifications	$500				$50
Commissioning, Re/Retro-Commissioning	$900				
Energy Related Process Improvements	$300				
Heating, Ventilating and Air Conditioning (HVAC)	$1,200				
Lighting Improvements	$525				$75
Small Modular Reactor (SMR)	$1,000,000				
Small Pump Storage	$20,000				
Utility Scale Solar Photovolaic (USS-PV)	$10,000				
Green Gas Combined heat and power(CHP)	$10,000				
Total Estimated Identified Project Cost FY15 - FY20	**$1,045,646**	**N/A**	**N/A**	**N/A**	**N/A**
Total Project Cost (Actual) FY11 - FY14	**$5,342**	**$1,430**	**$1,059**	**$1,148**	**$1,705**

(1) Projects identified and added to CEDR by former Energy Manager - some details cannot be verified
(2) Savings based on Hawthorne Effect and calculated at 2% of annual consumption
(3) Estimated based only on installations to date
(4) Preexisting condition found to complicate. Savings different than estimate. Actual TBD

Proposed						Estimated Annual Electric Savings MWh/YR	Estimated Annual Energy Savings Btu/YR	Estimated Annual GHG Emmissions mt CO_2/YR
FY15 ($K)	FY16 ($K)	FY17 ($K)	FY18 ($K)	FY19 ($K)	FY20 ($K)			
								0
$200	$200	$150	$150	$150	$150			
$100	$100	$100	$100	$100	$100			
						286		177
$250							642	34
$150							TBD	TBD
$150							TBD	TBD
$50						N/A	N/A	N/A
						TBD	TBD	TBD
						14		9
$50						TBD	TBD	TBD
						TBD	TBD	TBD
						39	0	24
						173	0	107
						1,511	0	935
						TBD	TBD	TBD
							3,478	185
							2,750	146
							1,430	76
							12,444	660
							2,850	151
							2,935	156
$17							1,780	94
$37							4,070	216
$42							262	14
$75	$75	$75	$75	$75	$75	TBD	TBD	TBD
$150	$150	$150	$150	$150	$150	TBD	TBD	TBD
$50	$50	$50	$50	$50	$50	TBD	TBD	TBD
$200	$200	$200	$200	$200	$200	TBD	TBD	TBD
$75	$75	$75	$75	$75	$75	TBD	TBD	TBD
					$1,000,000			
					$20,000			
					$10,000			
					$10,000			
$1,596	**$850**	**$800**	**$800**	**$800**	**$1,040,800**	**2,022**	**32,641**	**2,984**
N/A	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**			

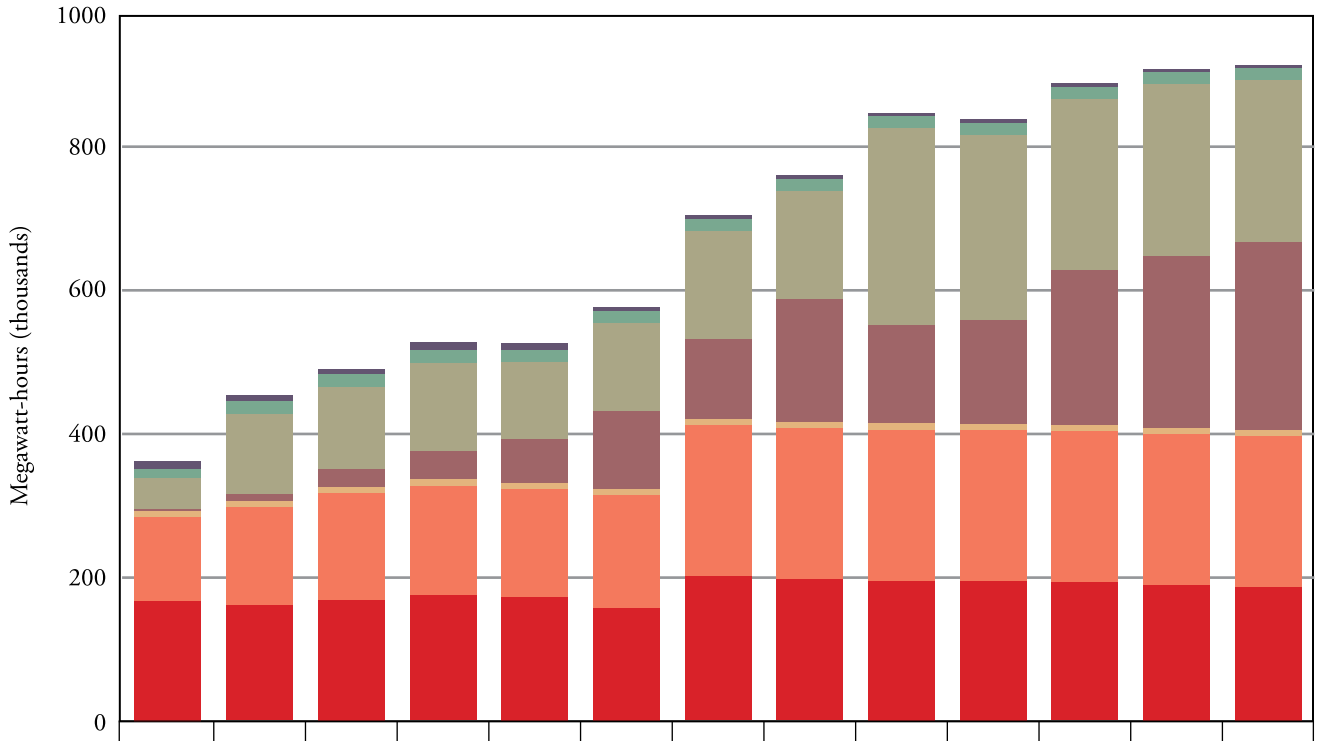
Table 10. ECM actual and planned overhead expenses

Summary of Overhead Funded Projects ($K)				
Category	**FY13 Actual**	**FY14 Planned**	**FY15 Projected**	**FY16 Projected**
Advanced Metering Systems	$345	$775	$600	$0
Audit/Evaluation (Energy, Water)	$215	$200	$200	$200
Behavioral Modification	$40	$25	$0	$0
Building Envelope Modifications	$0	$50	$75	$75
Commissioning Re-/Retro-Commissioning	$79	$196	$217	$150
Energy Related Process Improvements	$0	$0	$50	$50
Heating, Ventilating and Air Conditioning	$235	$334	$279	$200
High Performance Sustainable Buildings	$125	$50	$100	$100
Lighting Improvements	$109	$75	$75	$75
Total	**$1,148**	**$1,705**	**$1,596**	**$850**

VI Electrical Energy Projections and High Energy Mission Specific Facilities

ORNL has categorized six facilities as HEMSFs. Those facilities use a substantial portion of ORNL's total electrical power. In FY 2008 ORNL HEMSFs used more than 194,000 MWh of electricity, over half of all ORNL power. By FY 2020 ORNL's HEMSFs are projected to use about 725,000 MWh, accounting for about 80% of all ORNL power.

Figure 15 illustrates the historical and projected power consumption for ORNL's HEMSFs. All of ORNL's HEMSFs are designated as "excluded" facilities in the DOE FIMS database; that is, their energy use is excluded from calculations that track progress toward energy intensity reduction goals. The ORNL HEMSFs are listed with definitions below, and a brief narrative describing each facility is included at the end of this section.



	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
HRIBF	10582	9212	7620	10955	8780	3,238	3,238	3,238	3,238	3,238	3,238	3238	3238
HFIR	13557	17611	18298	18700	17233	17102	17102	17102	17102	17102	17102	17102	17102
CSB HPC	42504	110980	114285	121705	107128	119629	150937	150937	275054	258143	238442	239467	225482
MRF HPC	3082	10490	24008	39760	61332	109065	111033	170820	136656	145197	216372	239148	261924
CNMS	8147	8311	8075	8828	8413	8230	8230	8230	8230	8230	8230	8230	8230
SNS	116879	13513	148457	151058	149937	149978	209188	209188	209188	209188	209188	209188	209188
Base Site Usage	167274	161437	168902	175049	172395	167243	169326	165632	164150	162697	161355	159955	157287

Figure 15. ORNL's high energy mission specific facilities.

Definitions and Identification of ORNL HEMSFs

HRIBF	Holifield Radioactive Ion Beam Facility	Accelerator
HFIR	High Flux Isotope Reactor	Fission reactor
CSB HPC	Computational Sciences Building	High performance computing
MRF HPC	Multiprogram Research Facility	High performance computing
SNS	Spallation Neutron Source	Accelerator
CNMS	Center for Nanophase Materials Sciences	Nano-science facility
Base Site Usage	Power usage in addition to that of HEMSFs	Offices/labs/support

Summary and Update on Electrical Projections

HRIBF programs have experienced a pause in funding, resulting in a decreased number of research activities and a reduction of about 50% in energy consumption. Unless additional funding is identified, continued decreases in research will lead to a 50% reduction in energy consumption in FY 2014 and beyond. Significant growth is projected for both CSB and MRF HPC moving forward. Overall, HPC at ORNL is expected to increase 50% by FY 2020. Research activities at SNS are also expected to increase in FY 2014 and beyond. ORNL anticipates an additional 9% in campus development in FY 2015, continuing through FY 2020. The new development is expected to be in the form of energy-efficient facilities, while efforts to transition from older, less efficient facilities will continue in order to optimize campus energy consumption.

Holifield Radioactive Ion Beam Facility

Holifield Radioactive Ion Beam Facility

HRIBF was operated as a national user facility for DOE from 1996 to 2011, producing high quality beams of short-lived, radioactive nuclei for studies of exotic nuclei and astrophysics research. These nuclei were produced when intense beams of light ions from the Oak Ridge Isochronous Cyclotron strike highly refractory targets. Research at HRIBF was scaled back in FY 2012 to match a reduction in funding. The research reduction is expected to continue until additional programmatic funds are identified.

High Flux Isotope Reactor

Operating at 85 MW, 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 contain 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.

High Flux Isotope Reactor

Computational Sciences Building and Multiprogram Research Facility—High Performance Computing at ORNL

CSB and MRF are 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, the latest incarnation, Titan, was named the world's fastest computer at 17.59 sustained petaflops—10 times faster than its predecessor. Equally important, total energy consumption for Titan increased by only 10%, thus making Titan the third most efficient computer in the world—and Titan dwarfs the system capability of the two small systems that are slightly more efficient.

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 can't be accomplished anywhere else.

Looking to the future, the facility is moving forward with a roadmap that by 2021 will deliver an exascale supercomputer—one able to deliver 1 million trillion calculations each second—while still maintaining a modest carbon footprint.

Computational Sciences Bldg

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 the smallest samples of physical and biological materials than ever before possible. With resources that eventually will 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 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. SNS achieved a new power record of 1.4 MW in September 2013.

Spallation Neutron Source

Center for Nanophase Materials Sciences

CNMS, colocated 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.

Center for Nanophase Materials Sciences

VII Utility Usage, Costs, and Projections

ORNL's utility services (Figure 16) 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, chilled water service, and direct cooling applications. Steam is generated from a combination of wood, fuel oil, and natural gas. Natural gas and fuel oil are also used in direct heating applications. Potable water use supports mission critical process applications and domestic use, including restrooms and drinking water.

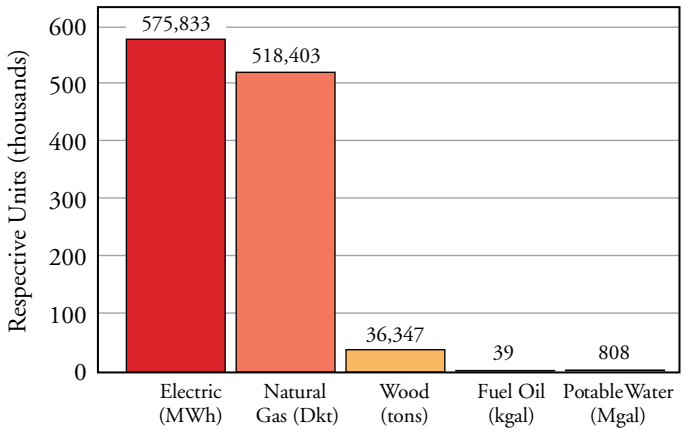


Figure 16. Utility services at ORNL (consumption in natural units).

Utility Use

At 68.0% of total energy consumption (in millions of British thermal units), electricity is the largest energy commodity at ORNL (Figure 17). Electrical services dominate ORNL's energy, in part due to HEMSF operations. In FY 2013, HEMSFs consumed 71% of ORNL's electrical energy, and current projections show an increase to 82% by the FY 2020 target/goal year. HEMSFs currently consume 45% of all ORNL water, and that number is expected to rise to 74% by FY 2020.

Biomass products (wood) serve the BSP, which accounts for 13.9% of ORNL's energy consumption. Natural gas is used to generate steam to supplement demands above the BSP capacity (winter operations) and for biomass outages. Natural gas is also used for the Melton Valley Steam Plant, SNS, and other direct heating/research applications for a total of 17.9% of the energy consumption at ORNL.

FY 2013 was the first full year of savings from BSP operations. Previously steam was provided by dual-fuel boilers (natural gas and fuel oil). Fuel oil is no longer expected as a standard service for ORNL's steam plant but would be available for curtailment periods if necessary.

Fuel oil is currently used only for direct heating applications and emergency generator services. Fuel oil accounts for only 0.2% of the energy consumed at ORNL.

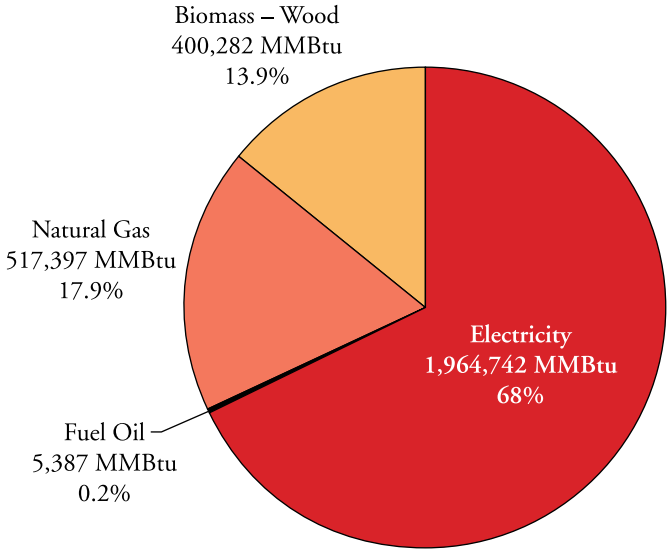


Figure 17. FY 2013 utility energy consumption and percentages.

Utility Costs

As electricity is by far ORNL's largest purchased energy source, it is also the most costly at $34,046,559 in FY 2013 (Figure 18). ORNL uses the TVA seasonal manufacturing rate for the best value based on its high and consistent demand load. SNS uses the TVA seasonal time-of-use rate to take advantage of process cycles and scheduling within the rate structure.

Natural gas and wood follow electricity, with respective costs of $2,330,537 and $1,799,216. Water is the next largest commodity at $956,173. Fuel oil is the least used and least costly at $125,760 in FY 2013.

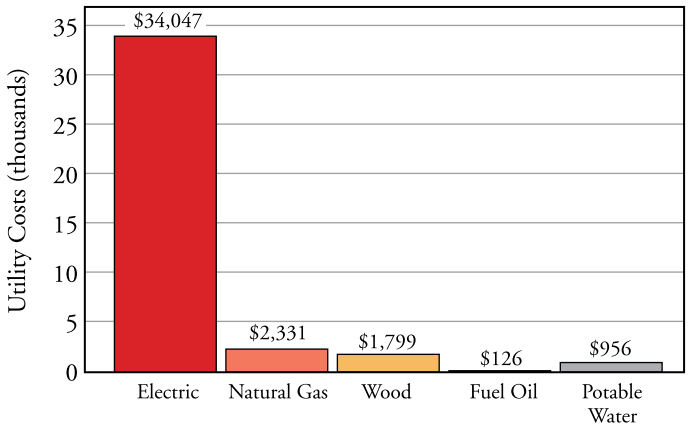


Figure 18. ORNL utility costs for FY 2013.

Electrical Cost Projections

TVA's rate structures include basic rate components for demand and energy. An increase in the basic rate structure that will increase the overall effective rate will occur in FY 2014. However, a major factor in the overall rate is the total fuel cost, which is a variable that accounts for the fuel mix TVA uses to generate power. In late FY 2013, TVA's rate was lower than expected as a result of greater use of hydropower (a less expensive and cleaner fuel source) due to favorable weather conditions. The trend in reduced total fuel cost related to continued additional hydropower use is expected through early FY 2014, but the degree of impact is uncertain.

TVA periodically issues a basic rate structure increase, but is also strongly affected the actual total fuel cost. TVA prides itself on competitive electrical rates and strives to improve its fuel mix for good economic and environmental benefits to its customers.

Figure 19 includes anticipated TVA rate increases as well as a strong growth in electrical consumption for HEMSFs through FY 2020.

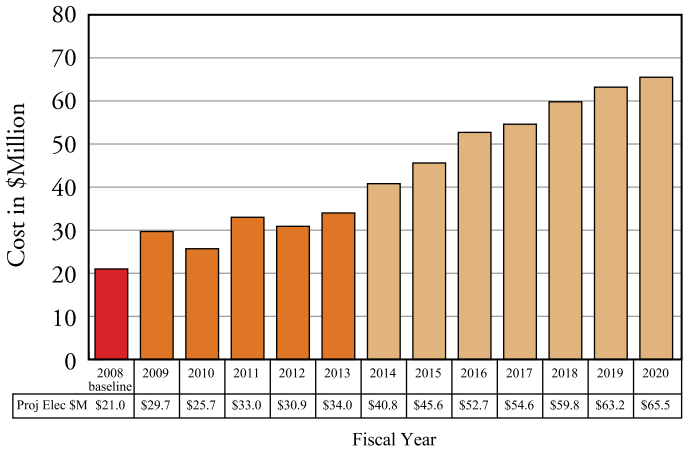


Figure 19. Projected ORNL electrical energy costs.

Appendixes

OE BUILDING EXCLUSION
SELF-CERTIFICATION FORM
FY 2013

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

TO: Sustainability Performance Office

DATE: December 4, 2013

SUBJECT: Self-Certification Form for the Energy Intensity Goal of EISA 2007

Each buildings 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 Report 063 dated December 3, 2013 for Oak Ridge National Laboratory, and listed on pages 2 through 5 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

M. G. Branton for JOM

DOE Site Office Official – signature

12-13-2013

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	
161 kV Substation	0901						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								Excludes only the programmatically essential data center housed in this building. A series of measures have been implemented to maximize efficiency through equipment and operational optimization but the energy consumption profile of the data center's high performance computers remains significantly different from that of a conventional building and is therefore sub-metered at a very granular level. Utilizing this metering, the data center's Power Usage Effectiveness (PUE) can be calculated to ensure maximized efficiency and alignment with benchmarks.
Computer Center (part of Computational Sciences Building)	5600								Excludes only the programmatically essential data center housed in this building. A series of measures have been implemented to maximize efficiency through equipment and operational optimization but the energy consumption profile of the data center's high performance computers remains significantly different from that of a conventional building and is therefore sub-metered at a very granular level. Utilizing this metering, the data center's Power Usage Effectiveness (PUE) can be calculated to ensure maximized efficiency and alignment with benchmarks.
Holifield Heavy Ion Research Facility	6000						X		The energy is required to support the facility's research mission. The facility incorporates 2 accelerators and a high-voltage isochronous cyclotron generator to create various radioactive ion beams for research targets. The facility's energy intensity is about twice that of standard buildings at ORNL. Energy loads are not influenced by conventional building energy conservation measures. Significant energy reductions are not practical without affecting research operations.
161 kV 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 ---

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	
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.
Center for Nanophase Materials Sciences	8610						X		This is a relatively new (2003) modern facility. Energy intensity is required for research missions involving materials, neutron and X-ray scattering, electron microscopy and spectroscopy, and other processes, and the facility also incorporates 10,000 square feet of Class 100, 1000, and 100,000 clean room space. The energy intensity of the facility is about three times that of a standard building at ORNL. Significant energy reductions are not practical without affecting research.
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 ---

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	
(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) Switch Yard	8911						X		--- see SNS comment above ---
(SNS) Central Exhaust Facility	8915						X		--- see SNS comment above ---

Oak Ridge National Laboratory Right-Sizing of Fleet Management Plan

An evaluation of the Oak Ridge National Laboratory (ORNL) government vehicle fleet has determined that all of the remaining 439 vehicles are mission critical. ORNL met the FY 2012 reduction of 58 vehicles, bringing the total fleet count to 439. This was a reduction of 52% of our General Purpose and Administrative vehicles from our 2005 baseline. Please note that 83 percent of our remaining vehicles are Alternative Fuel Vehicles (AFVs). Enclosure 1 provides a description of how the 439 remaining vehicles are deployed across ORNL. All 439 vehicles are necessary for the continued safe and cost-effective operation of ORNL facilities and missions on a 50 square mile site with over 4,500 employees.

ORNL has been aggressively managing our fleet since 2000. We have pursued vehicle reductions; converted to alternative fuels; modernized the fleet; and employed alternative modes of transportation such as taxis, a travel pool, low-speed vehicles (electric and biodiesel), a fleet of shared bicycles, and convenient walking paths. The success of our decade-long "leaning, greening and right-sizing" of the ORNL fleet has contributed to ORNL winning numerous sustainability awards involving fleet management. Enclosure 2 is a summary of our fleet management accomplishments.

Reduction of any additional vehicles from the ORNL fleet would have consequences that we do not believe were intended by Secretary Chu, specifically the reduction of AFVs, including Hybrid Electric Vehicles (HEVs). Our aggressive procurement of AFVs in the past has resulted in a fleet with 83 percent AFVs, the remaining non-AFVs primarily being Special Purpose vehicles. For the FY 2012 reduction of 58 vehicles, we lost 42 AFVs, including 5 HEV sedans. Any further reduction would again result in loss of AFVs.

A second unintended consequence of additional reduction to the ORNL fleet is the likely increase in ORNL's carbon footprint. There will be an overall increase in petroleum consumption on-site due to ORNL staff using their personal vehicles to travel to meetings and appointments because government vehicles are not available. The vast majority of personal vehicles are non-AFVs, while 83 percent of our fleet is AFVs. We have already experienced this conversion as a result of the FY 2012 reduction, with increased demand for and utilization of short-term parking for personal vehicles in place of government vehicle parking. This would be magnified by any further reduction in government vehicles.

Again, based on our mission critical need to retain the 439 remaining vehicles in our fleet and the 52% reduction in General Purpose and Administrative vehicles we have already achieved, ORNL is requesting a waiver to any further vehicle reductions.

Enclosure 3 contains ORNL's Local Use Objectives for FY 2012 which includes the vehicle categories, objectives for each category as listed below, and the mileage for each category as required in the electronic message of October 23, 2012, from Caryle Miller, *CH 1 to SC Guidance Right-Size Fleet 102312*.

Vehicle Categories	Local Use Standard (Miles required per FY)
Small Geographical Area	1200
Operations/Maintenance	1500
DOE Site Office	1200
Buses/Taxis	3000
Special Purpose	No mileage standard

Enclosure 4 contains ORNL's Proposed Local Use Objectives for FY 2013 as requested in the *CH 1 to SC Guidance Right-Size Fleet 102312*.

[For complete information on Enclosures 3 and 4, please contact Kathye Settles, 865-574-4326, settleske@ornl.gov]

Office of Science – Oak Ridge National Laboratory Right-Sizing of Fleet Management Plan							
A	B	C	D	E	F	G	H
Site	**2005 Baseline Vehicles in Fleet**	**Total Number of Vehicles in Fleet as of December 31, 2012**	**Mission Critical Vehicles in Fleet as of December 31, 2012**	**Non-Mission Critical Vehicles in Fleet as of December 31, 2012**	**Total Number of Vehicles in Fleet as of September 30, 2013**	**Mission Critical Vehicles in Fleet as of September 30, 2013**	**Non-Mission Critical Vehicles in Fleet as of September 30, 2013**
Oak Ridge National Laboratory	515	439	439	0	439	439	0

Enclosure 1

Vehicle Deployment at Oak Ridge National Laboratory

In support of Secretary Chu's fleet reduction initiative, the Oak Ridge National Laboratory (ORNL) reduced its fleet by 58 vehicles in FY 2012. This is a 52% reduction in our General Purpose and Administrative vehicles from our 2005 baseline. The remaining 439 ORNL fleet vehicles are assigned to functions that cannot withstand additional reductions without impacting critical mission elements or the ability to provide for a safe, secure, and environmentally sound work environment on a 50 square mile site with over 4,500 employees. These functional categories and vehicle numbers are shown in the following table.

Vehicle Functional Categories	Quantity
Emergency Response Vehicles	17
Special Purpose Vehicles	115
Service and Delivery Vehicles	142
Field Research Support Vehicles	60
Scientific Operations Support Vehicles	8
General Purpose and Administrative Vehicles	82
Buses and Taxis	7
DOE-ORNL Site Office Vehicles	8
Total	**439**

All of these functional categories for vehicle deployment represent critical mission elements for ORNL. The following is a description of each of these functional categories.

17 **Emergency Response Vehicles** – The vehicles in this category include fire trucks, ambulances, security vehicles, and spill response vehicles. They enable ORNL's mission by providing the necessary level of emergency response capability to protect employees, the public, government property, and the environment from the effects of operational emergencies, fires, vehicle accidents, medical incidents and related events. This function also provides Safeguards, Protective Systems, Security Systems, and Technical Security for the ORNL campus including support to other site contractors, as well as controlling access authorization to ORNL by subcontractors, vendors, visiting scientists and researchers, and the general public.

115 **Special Purpose Vehicles** – The vehicles in this category are specialty vehicles or heavily modified vehicles that have a singular purpose. Most of them require a Commercial Driver's License to operate. They include a range of vehicle types such as bucket trucks, dump trucks, trash compactor trucks, fuel trucks, semi tractors, lift trucks with bed mounted cranes, wreckers, box trucks, flat bed and stake bed trucks, liquid nitrogen truck, compressed gas cylinder truck, hydroseeder, etc. A number of these vehicles serve double duty by performing as snow plows and salt spreaders in the winter months. These special purpose vehicles support every mission and operation at ORNL by maintaining the power and other utility operations, roads and grounds maintenance, hoisting and rigging, emergency generator and fleet maintenance, bulk material delivery, liquid nitrogen and compressed gas delivery, radiological material movement, and waste management.

142 **Service and Delivery Vehicles** – The vehicles in this category are primarily pickup trucks and cargo vans. Most of these vehicles are outfitted with accessories that aid in the safe and cost-effective execution of work, such as lift gates, auto-cranes, material racks, tool boxes, welders, air compressors, light bars, trailer hitches, etc. A number of them are crew cabs and/or have open beds for maximum flexibility in moving personnel with their materials. These vehicles support the continued operation of ORNL buildings and infrastructure. ORNL has 330 buildings and 77 trailers that range from nuclear reactors to office buildings, which are located on over 34,000 acres (greater than 50 square miles). Accomplishing ORNL's mission requires maintenance and operations for these facilities and systems on a 24/7 basis. Approximately 1,000 craft personnel, technicians, engineers, and their supervisors use these vehicles for transportation to and from work areas with their tools, material and equipment.

60 **Field Research Support Vehicles** – The vehicles in this category are primarily pickup trucks, vans, and SUVs. Many of these vehicles have been modified to support specific field functions such as sampling, environmental and radiological monitoring, and equipment testing. About one-fourth of them are four wheel drive vehicles. These vehicles are assigned directly to research organizations or to support organizations that enable field research, such as safety, health physics, environmental and waste management. They are critical to conducting field research on and around the Oak Ridge Reservation as well as at remote locations across the country.

8 **Scientific Operations Support Vehicles** – Six of these vehicles are cargo vans and one is a crew cab pickup assigned directly to research organizations for the purpose of transporting scientific equipment and research samples between research/user facilities on-site and offsite. The eighth vehicle is a box truck modified for use by the calibration crew. These vehicles are critical to enabling laboratory research and maintaining the integrity of the research equipment.

82 **General and Administrative Support Vehicles** – The vehicles in this category include 34 hybrid electric sedans, 25 passenger vans, 20 unmodified pickup trucks, 2 SUVs, and one other sedan. All of these vehicles are Alternative Fueled. Most of these vehicles are assigned directly to

research divisions to support their daily activities. There are over 2,500 scientists and engineers at ORNL that conduct basic and applied research and development, as well as provide technical assistance to other government agencies and private industry. These vehicles are essential to maintain active participation in collaborative and outreach programs. Many of ORNL's research facilities are located considerable distances from the central campus (see table following narrative). Daily interactions between these facilities and the ORNL central campus require the use of government vehicles. This vehicle category was reduced by 58 vehicles in FY 2012, which is a 52% reduction from our 2005 baseline of 158.

7 **Buses and Taxis** – ORNL has three buses, 3 taxis, and 1 ADA van. These vehicles support the movement of personnel and throughout ORNL. They are used for tours, conferences, students, and special events. One of the buses supports the daily public tours from the American Museum of Science and Energy from May through September. As the General Purpose and Administrative vehicles have been reduced, reliance on the daily taxi service and buses for special events has increased.

8 **DOE Site Office** – The vehicles in this category include 5 passenger vans, 2 hybrid electric sedans, and one four wheel drive SUV. The forty-eight personnel in the DOE ORNL Site Office require these vehicles to adequately conduct oversight of ORNL research and operations. Field presence is critical and, as shown in the table following the narrative, a number of ORNL research and support facilities are a considerable distance from the Site Office location in Building 4500N. Additionally, daily interaction with the Oak Ridge Office is required, and the Federal Office Building is located 11 miles from the ORNL Site Office.

Conclusion

ORNL reduced the fleet by 58 vehicles in FY 2012, per the Secretary's initiative. ORNL also has a fleet of 152 low speed vehicles to supplement the fleet within contiguous areas of the ORNL campus. However, low speed vehicles are quite limited in the ability to move materials and equipment. Due to the geographic separation of facilities and the need to transport the personnel, tools, and material needed for mission support, further conversion from fleet vehicles to low speed vehicles is not a viable alternative at ORNL. The remaining fleet vehicles are mission critical as well as necessary to ensure safety, health and environmental compliance. The following table gives examples of the distances from the center of ORNL at Building 4500N to a number of the important research and support facilities.

Research/Support Facility	Distance from 4500N
High Flux Isotope Reactor and REDC	3 miles
Spallation Neutron Source and Center for Nanophase Materials Sciences	4 miles
Carbon Fiber Technology Facility	6 miles
Excess Property Sales Facility	9 miles
DOE Oak Ridge Federal Office Building	11 miles
National Transportation Research Center and Manufacturing Demonstration Facility	13 miles

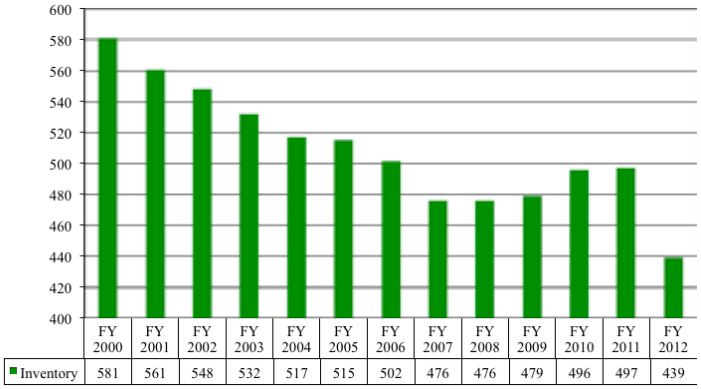
Enclosure 2

ORNL FLEET MANAGEMENT ACCOMPLISHMENTS

ORNL has been aggressively managing the fleet since 2000. Between 2000 and 2005, we concentrated on fleet reduction and the purchase of E85 Alternative Fuel Vehicles (AFVs), as limited funding would allow. However, chronic underutilization of the fleet persisted. A Lean Six Sigma study of the ORNL fleet conducted in 2005/2006 determined that in addition to fleet reductions and AFVs, we needed to modernize the fleet and employ alternative modes of transportation.

Fleet Reduction

The chart below shows the steady reduction in ORNL fleet numbers from 2000 to 2008. The increase of 3 vehicles in 2009 was a result of the waste management operations moving back to the Office of Science from EM. In 2010, ORNL requested and was granted an increase to the fleet of 25 vehicles to accommodate the significant growth of the Laboratory since 2005. This growth included expansion to the Spallation Neutron Source on Chestnut Ridge, budget growth of over $500M, and staff growth of over 500. We operated under the approved fleet level of 504 in 2010 and 2011. At the end of 2011 we implemented a 58 vehicle reduction in compliance with the first phase of Secretary Chu's 35% fleet reduction campaign.



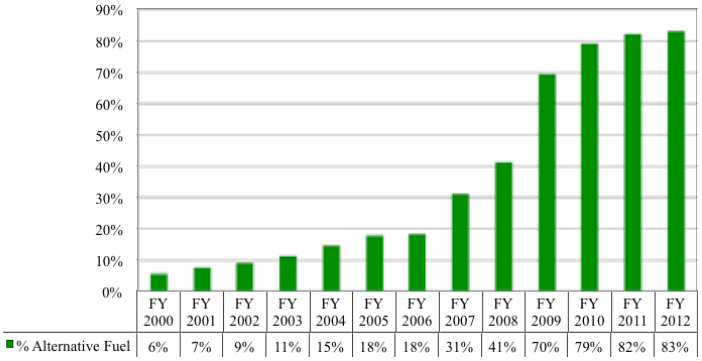
Reduction in Fleet Inventory

Alternative Fuels and Vehicles

ORNL has had a fleet of E85 fueled AFVs since the early 1990's, which were fueled on-site from a 500- gallon tank. Knowing this would be a limitation to expanding the number of E85 vehicles in the fleet, a new 8,000-gallon tank was installed in 2000/2001. The figure top right shows how the percentage of AFVs in the ORNL fleet has increased since 2000. From 2000 to 2006, the increase was limited by funding. In 2007, as a result of Lean Six Sigma study, the monthly vehicle charge back rate was increased (essentially doubled) in order to generate funds for vehicle replacements to modernize the fleet. This allowed us to significantly increase our replacement rate of older gasoline vehicles with new E85 AFVs.

In 2009 two significant things occurred to dramatically increase our percentage of AFVs. First, we converted our on-site 6000-gallon diesel UST and our entire diesel fleet (except emergency vehicles) to B20 biodiesel, making them AFVs. Second, we began receiving what would total 113 ARRA funded replacement vehicles from GSA. Most of these were AFVs, including 41 hybrid electric vehicles (HEVs).

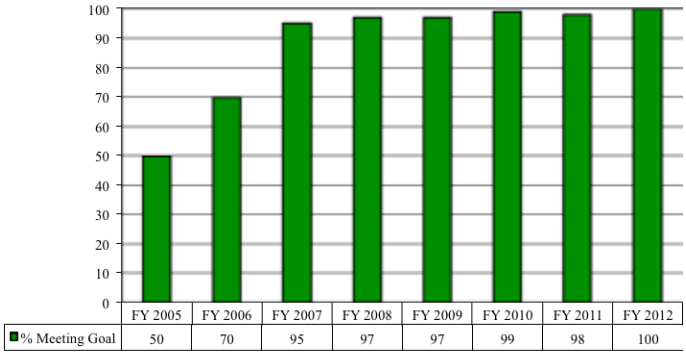
The percentage of AFVs in the ORNL fleet continued to increase in 2010 and 2011 because our replacement policy is to not purchase gasoline-powered vehicles unless there is no AFV available for the specific vehicle needed. For example, in FY 2011 we replaced 24 vehicles, including 14 gasoline-powered, but none of the replacement vehicles was gasoline. As of September 2012, 83% of our fleet is AFVs.



Percent of Alternative Fuel Vehicles

Improved Utilization through Modernization

Another desired outcome of the Lean Six Sigma recommendation to modernize the fleet by doubling the charge back rate was to provide a financial incentive for organizations to turn in underutilized vehicles. This did occur, as you can see in the 25% jump in vehicles in meeting their utilization goals in FY 2007 (figure below). We have continued to exceed the DOE nation-wide utilization goal of 94% since 2007 and, in 2010, only one vehicle in the ORNL fleet did not meet the goal.



Vehicle Mileage Utilization

Alternative Modes of Transportation

ORNL has long employed a number of alternative modes of transportation on-site. These were formalized and expanded in 2007/2008 under our Green Transportation Initiative. Today we utilize 3 on-site, on-call taxis. From 2007 through 2011 we also had a travel pool of 4 E85 vehicles, but these had to be eliminated in the first phase of the mandatory fleet reduction. We have 125 share bikes in our "Bike It Green" program used by trained staff as an alternative to using a vehicle. We have also installed walking paths between facilities.

ORNL also employs 152 Low Speed Vehicles (LSVs) made up primarily of Kubotas which run on biodiesel, neighborhood electric vehicles, and electric golf carts. These vehicles work well for personnel and small equipment moves within each geographical unit of ORNL. However, they are not suitable for travel between the Central Campus and areas like SNS (4 miles), HFIR (3 miles), and ECGR (4 miles) due to distances, speed limits, and traffic safety.

Expanding the use of LSVs in order to reduce fleet vehicles is not a viable or cost-effective option at ORNL. Heavy duty LSVs actually cost more than 2-wheel drive pickup trucks. They have a very limited capacity for carrying materials and equipment. As stated above, they are not suitable for travelling the considerable distances between many of the ORNL facilities.

Recognition of Success

The success of our decade-long "leaning, greening and right-sizing" of the ORNL fleet has contributed to ORNL winning numerous sustainability awards involving fleet management, including:

> 2008: DOE Office of Science Best In Class Pollution Prevention Award, DOE P2 Star Award, and the White House Closing the Circle Award for our Green Transportation Initiative.
>
> 2009: DOE E-Star Award and Tennessee Chamber of Commerce & Industry Water Quality Award and Achievement Certificate.
>
> 2010: DOE Federal Energy Management Program Management Award, DOE Office of Science Noteworthy Practice Award, DOE E-Star Award, Federal Energy & Water Management Award, and Tennessee Department of Environment Pollution Prevention Partnership Performer Award.
>
> 2011: DOE E-Star Award Honorable Mention, Tennessee Chamber of Commerce and Industry Award for Comprehensive Environmental Excellence, East Tennessee USGBC – Green Light Award for Exemplary Contributions to Sustainability in the Built Environment.

Conclusion

ORNL has worked hard to effectively manage its fleet and ensure the minimum fleet size to support the mission. We have also aggressively converted to alternative fuels and procured AFVs to the point that 83% of our fleet is now AFVs. We have also employed alternative models of transportation and have essentially reached a maximum efficient utilization of LSVs due to the size and speed limits at ORNL.

While we met the first phase of the fleet reduction in FY 2012 by eliminating 58 vehicles (52% of our General Purpose and Administrative vehicles compared to 2005), it was not without negative consequences. We had to eliminate our pool of loaner vans and travel vehicles. We had to eliminate 42 AFVs, including 5 model year 2010 hybrid-electric sedans.

The remaining 439 vehicles in the ORNL fleet cannot be reduced further and still meet Secretary Chu's mandate to do so "Without sacrificing either critical mission elements or our commitment to operate in a safe, secure and environmentally sound manner."

Appendix C

ORNL Consolidated Energy Data Report Submission

The ORNL Consolidated Energy Data Report along with 2013 Greenhouse Gas Verification Data Elements was electronically submitted via email from Bryce Hudey to Mary Rawlins (OSO, Federal Project Director).