



Sustainable NREL

SITE SUSTAINABILITY PLAN FY 2017

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Sustainable NREL

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Cover: NREL Director Dr. Martin Keller, shares the executive management vision and priorities with NREL staff at an All Hands meeting.

Right: NREL is committed to continuous improvements and advances in energy management.



Nomenclature

AFV	alternative fuel vehicle	gCO₂e	grams of carbon dioxide equivalent	PCard	purchase card
ANSI	American National Standards Institute	GGE	gasoline gallon equivalent	PEV	plug-in electric vehicles
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers	GHG	greenhouse gas	PPA	power purchase agreement
Btu	British thermal unit	GSA	General Services Administration	PUE	power usage effectiveness
CRADA	cooperative research and development agreement	GSF	gross square foot	PV	photovoltaic
DOE	United States Department of Energy	HPCDC	high performance computing data center	REC	renewable energy credit
DOE GO	DOE's Golden Field Office	HPSB	high performance sustainable building	RFHP	Renewable Fuel Heat Plant
DRCOG	Denver Regional Council of Governments	HVAC	heating, ventilation, and air conditioning	RSF	Research Support Facility
E-85	high-level ethanol (85%) fuel	IC	Intelligent Campus	RTD	Regional Transportation District
ECM	energy conservation measure	ILA	industrial, landscaping, and agricultural	S&TF	Science and Technology Facility
EISA	Energy Independence and Security Act	ISO	International Organization for Standardization	SEMP	Strategic Energy Management Plan
EO	Executive Order	kW	kilowatt	SF₆	sulfur hexafluoride
EnMS	Energy Management System	kWh	kilowatt-hour	SITE	Sustainability, Infrastructure Transformation, Engineering
EPA	United States Environmental Protection Agency	LEED®	Leadership in Energy and Environmental Design	SPOFOA	Sustainability Performance Office Funding Opportunity Announcement
EPEAT	Electronic Product Environmental Assessment Tool	MFD	multifunction device	SSPP	Strategic Sustainability Performance Plan
EPP	Environmentally Preferable Product	MFCO₂e	metric tons of carbon dioxide equivalent	STM	South Table Mountain
ESIF	Energy Systems Integration Facility	MW	megawatt	T&D	transmission and distribution
FEMP	Federal Energy Management Program	MWh	megawatt-hour		
ft²	square feet	N/A	not applicable		
FTLB	Field Test Laboratory Building	NEPA	National Environmental Policy Act		
FY	fiscal year (October 1st – September 30th)	NREL	National Renewable Energy Laboratory		
gal	gallons	NWTC	National Wind Technology Center		
		PC	personal computer		

Executive Summary

VISION

The U. S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) is recognized as a leader in sustainability as evidenced by its implementation of effective sustainability measures that continue to meet federal mandates. NREL's sustainability program supports the laboratory's success by engaging employees in applying what is learned through research and development in the facilities and infrastructure systems that serve its campuses. Integrating internal initiatives that are vital to advancing the national renewable energy marketplace, NREL strives to expand the use of these initiatives to a global audience.

PLANNING SYNOPSIS

The potential impacts of climate change can be mitigated by what NREL does now to prepare for and adapt to climate variations and extreme weather events. The NREL campuses are a dynamic model of innovative adaptation and mitigation strategies for climate change. Integrated strategic planning across the laboratory is crucial to realizing new endeavors and maintaining operational excellence. The Strategic Energy Management Plan (SEMP) is the foundational document that details NREL's philosophy and identifies tactical measures for the laboratory to achieve goals set forth in the presidential Executive Orders (EOs) and DOE statutes. For example, the SEMP defines objectives for building controls and microgrids that, when implemented, achieve elements of NREL's Climate Change Resiliency Action Plan. Together, these plans create a foundation for strengthening NREL's resiliency. Furthermore, the laboratory integrates its business goals within the Site Sustainability Plan to guide the implementation of energy-saving technologies, project methodologies, and behavior adoption, ultimately enhancing the deployment that assists NREL and the nation in meeting short-term and long-term sustainability goals.

NREL actively seeks partnerships with colleagues in other laboratory centers to expand expertise and leverage capabilities for

sustainability pursuits. In addition, NREL's campuses often serve as testing sites for new sustainability innovation and to help resolve technical and operational barriers. This integrated approach benefits research as well as operations.

NREL continues to meet EOs, federal regulations, DOE mission goals, and other targets related to sustainable and resilient facility operations, with the sustainability program serving as a mentorship resource for federal agencies' sustainable project initiatives. The laboratory partners with industry and academia to support these endeavors; it also hosts visitors from various professional fields to illustrate and share knowledge of sustainable research and operations, demonstrating performance, achievements, and how the measures can be replicated.

During FY 2016, NREL began to investigate several strategies identified in NREL's *A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory* (<http://www.nrel.gov/docs/fy16osti/64174.pdf>) and *A Resiliency Action Plan for the National Renewable Energy Laboratory* (<http://www.nrel.gov/docs/fy16osti/64175.pdf>). Three of the major activities were:

- Developing requirements for control technologies and processes to better manage electricity demand
- Conducting preliminary analysis of adding battery storage on the South Table Mountain (STM) campus to investigate the feasibility of "islanding" facilities during power outages
- Designing and constructing slope stabilization for eroding hillsides of the STM campus due to high peak storm events.

PEOPLE AND PROCESS

NREL staff is engaged in sustainability efforts lab-wide. With guidance and support from the sustainability program, NREL management consistently and continually emphasizes staff awareness of actions that support the lab's environmental objectives, creating a strong culture of sustainability. One example is the

Environment, Health, and Safety (EHS) group, which has added sustainability as a component of personnel performance reviews.

SUCCESSES

NREL meets nearly every DOE sustainability goal as indicated in the Summary Table of Goals and Targets. Some FY 2016 accomplishments are highlighted below:

Sponsorship: NREL's sustainability program is helping to build consensus among senior management, including associate lab directors and center directors, for a lab-wide understanding of sustainability. Expertise is enlisted from around the laboratory to catalyze staff to explore many facets of a single issue. These are the building blocks of success.

Climate Change: NREL has developed a lab-wide methodology document that illustrates how sustainable practices that address climate change are being put into practice. This record allows staff to take action, encouraging peer-to-peer network sharing of concepts that assist federal partners in understanding NREL's processes.

Net Zero: With the long-term goal of being a low-carbon-economy campus, NREL continues on its path to net zero energy. What started as a concept forged by researchers is becoming the reality of net zero buildings, and NREL continues to monitor and steward net zero energy performance.

Staff Synergies: Shared resources and varying opinions generate deeper understanding of energy issues and a breaking down of siloes among different NREL directorates. Partnerships between building operators, energy managers, and building area engineers are actively engaged in stewarding the operations of NREL facilities.

VISIONS FOR THE FUTURE

NREL has succeeded in developing a campus that is highly energy efficient, sustainable, and technologically state of the art. Now, new EO goals challenge NREL to make additional energy reductions. The concept of net zero energy may be on the horizon, but the challenge is rigorous, particularly for the high performance computing data center (HPCDC), which continues to grow its mission and is also the most significant energy user on NREL's campuses. Even utilizing all of NREL's STM campus real estate for renewable installations will not be enough to mitigate the ultimate 10-MW load consumption of the HPCDC. NREL will continue to investigate off-site green power contracts to offset energy use and meet NREL's objective of a low-carbon economy campus.

FUNDING

NREL makes a continuous effort to ensure its facilities operate efficiently. The complexity of these facilities' operations and their associated higher costs present funding challenges. By combining a suite of funding

sources—including the General Purpose Plant fund, General Plant Maintenance and Repairs fund, DOE Sustainability Performance Office funding opportunity award, power purchase agreements, energy savings performance contracts, renewable energy certificate sales, where possible, utility energy service contracts, in-house savings reinvestment funds, and site-wide budgeting—NREL is attempting to meet expanding needs. NREL experiences similar funding deficiencies in meeting EOs as do other DOE sites, and planning for the future continues to be challenging. One means of meeting the challenge is NREL's laboratory-directed research development fund, which serves as an investment in long-term global sustainability and addresses the lab's research mission by extending long-term sustainability for wider adoption. Another approach is demonstrating how research and operations dovetail so that each one leverages the other, encouraging partnerships for future funds. In addition, the energy saving reinvestment fund allows NREL to plant the seeds of energy conservation funding for future years—creating cyclical funding for the laboratory's vision and tasks ahead.

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Baseline	Performance Status Through FY 2016	Planned Action and Contributions	Risk of Non-attainment: High (H), Medium (M), or Low (L)
Goal 1: Greenhouse Gas Reduction					
1.1	50% Scope 1 & 2 GHG reduction by FY 2025 from a FY 2008 baseline (FY 2016 target: 22%)	FY 2008: 23,965 MTCO ₂ e	27,033 MTCO ₂ e of Scope 1 and 2 emissions, a 13% increase from the baseline without RECs 3,415 MTCO ₂ e of Scope 1 and 2 emissions, an 86% decrease from the baseline including RECs to offset Scope 2 emissions	Improvements to the RFHP should decrease natural gas consumption in FY 2017 Continue to explore opportunities to increase onsite renewable energy	L—NREL is on track to meet this goal
1.2	25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (FY 2016 target: 7%)	FY 2008: 7,490 MTCO ₂ e	8,177 MTCO ₂ e of Scope 3 emissions, a 9% increase from the baseline without RECs 6,621 MTCO ₂ e of Scope 3 emissions, a 12% decrease from the baseline including RECs to offset T&D emissions	Conduct employee commuter survey in FY 2017 Continue to promote teleworking and teleconferencing	L—NREL is on track to meet this goal
Goal 2: Sustainable Buildings					
2.1	25% energy intensity (Btu per GSF) reduction in goal-subject buildings, achieving 2.5% reductions annually, by FY 2025 from a FY 2015 baseline	FY 2015: 121,330 Btu/GSF	Energy use intensity decreased 3% from the baseline to 118,135 Btu/GSF	Attain third-party certification of ISO 50001:2011 Continue efforts to improve energy efficiency across the laboratory	L—NREL is on track to meet this goal
2.2	EISA Section 432 energy and water evaluations	N/A	Conducted EISA audits on four facilities that use 5% of total energy Evaluations are 100% complete for Cycle 2	Perform EISA audits for five facilities in the first year of Cycle 3 Implement the savings reinvestment fund	L—NREL will continue to meet this goal
2.3	Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate ¹	N/A	100% of NREL's buildings have energy meters (including electricity, natural gas, and renewables where appropriate) 100% of NREL's buildings have chilled water meters 100% of NREL's buildings have hot water meters (NREL does not use steam) 95% of NREL's buildings have potable water meters	Update thermal and electricity meters on the STM campus	L—NREL will continue to meet this goal
2.4	At least 17% (by building count) of existing buildings greater than 5,000 gross square feet (GSF) to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter	N/A	Six buildings (33%) of eligible buildings are compliant with the Guiding Principles	Pursue opportunities to integrate ECMs within existing facilities for expanded building portfolio compliance with the Guiding Principles Continued monitoring for HPSB to ensure energy optimization	L—NREL is on track to meet this goal

¹ Per NECPA (42 U.S.C Section 8253) the term "buildings" includes industrial, process, or laboratory facilities.

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2.5	Efforts to increase regional and local planning coordination and involvement	N/A	<p>Supported City of Lakewood efforts to install a new bike lane near the entrance of the STM campus</p> <p>Advocated with RTD to bring additional bus route service to the STM campus</p> <p>Participated in DRCOG's GoTober multi-modal month</p> <p>Developed and implemented improvements to the NEPA process with DOE GO partnership</p> <p>Monitored local bat populations with Rocky Flats National Wildlife Refuge</p>	<p>Advocate and support the opening of new RTD bus and light rail services in the region</p> <p>Actively monitor the STM conservation easement wildland fire burn area for erosion and habitat loss, and reseed the area if warranted</p> <p>Continue efforts to advocate for and improve access to alternative commuting options through regional and local organizations</p> <p>Continue participation in regional events promoting alternative transportation such as GoTober and Bike to Work Day.</p>	L—NREL will continue to meet this goal
2.6a	Net Zero Buildings: 1% of the site's existing buildings above 5,000 gross square feet intended to be energy, waste, or water net-zero buildings by FY 2025	N/A	One building (5%) of eligible buildings is net zero energy	Continue to operate the RSF as a net zero energy building	L—NREL is on track to meet this goal
2.6b	Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020	N/A	All new NREL buildings entering the planning process will be designed to achieve energy net-zero where feasible	Incorporate net zero energy designs in the planning process, where feasible, for all new facilities	L—NREL is on track to meet this goal
Goal 3: Clean & Renewable Energy					
3.1	"Clean Energy" requires that the percentage of an agency's total electric and thermal energy accounted for by renewable and alternative energy shall be not less than: 10% in FY 2016-2017, working toward 25% by FY 2025	N/A	<p>Clean energy including RECs accounted for 93% of total electric consumption</p> <p>On-site clean energy consumed at NREL accounted for 15% of total energy consumption</p>	Increase the thermal output of the RFHP by 50%	L—NREL is on track to meet this goal
3.2	"Renewable Electric Energy" requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY16-17, working toward 30% of total agency electric consumption by FY 2025	N/A	<p>Renewable electric energy including RECs accounted for 139% of total electric consumption</p> <p>On-site renewable electric energy consumed at NREL accounted for 21% of total electric consumption</p>	<p>Continue working with the GSA Region 8 Clean Energy Working Group to explore collaborative federal renewable energy project opportunities</p> <p>Supplement on-site renewables with REC purchase as necessary to meet goals</p>	L—NREL will continue to meet this goal
Goal 4: Water Use Efficiency and Management					
4.1	36% potable water intensity (gal per GSF) reduction by FY 2025 from a FY 2007 baseline (FY 2016 target: 18%)	FY 2007: 27.5 gal/GSF	Potable water intensity reduced 43% from the baseline to 15.6 gal/GSF	<p>Improve usage of the WeatherTRAK system</p> <p>Divert reverse osmosis waste water to cooling tower makeup water</p>	L—NREL is on track to meet this goal
4.2	30% water consumption (Gal) reduction of ILA water by FY 2025 from a FY 2010 baseline (FY 2016 target: 12%)	N/A	NREL does not use ILA water	N/A	N/A

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Baseline	Performance Status Through FY 2016	Planned Action and Contributions	Risk of Non-attainment: High (H), Medium (M), or Low (L)
Goal 5: Fleet Management					
5.1	30% reduction in fleet-wide per mile greenhouse gas emissions by FY 2025 from a FY 2014 baseline (FY 2016 target: 3%)	FY 2014: 422 gCO ₂ e/mile	Fleet-wide per mile greenhouse gas emissions were 657 gCO ₂ e/mile, a 56% increase from the baseline year	Reduce NREL's fleet by one vehicle based on the fleet reduction analysis Install fleet telematics in accordance with EO 13693 Continue to explore options for the acquisition of zero emission vehicles	H—Management Risk: NREL will need to acquire zero emissions vehicles for the fleet to meet this goal in the future.
5.2	20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter (FY 2016 target: 20%)	FY 2005: 7,722 GGE of petroleum fuel	Petroleum consumption increased 1% from the baseline to 7,810 GGE	Explore the possibility of replacing diesel campus shuttles with an EV bus	H—Management Risk: Continued use of diesel buses will make meeting this goal in the future difficult
5.3	10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter (FY 2016 target: 10%)	FY 2005: 7,507 GGE of alternative fuel	Alternative fuel use increased 25% from FY 2015 to 21,207 GGE	Continue to increase AFVs in an effort to increase alternative fuel consumption	L—NREL is on track to meet this goal.
5.4	75% of light duty vehicle acquisitions must consist of AFV's (FY 2016 target: 75%)	N/A	No light duty vehicles were acquired	Continue to acquire GSA-leased replacement vehicles with AFVs if available and as required	L—NREL will continue to meet this goal
5.5	50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025 (FY 2016 target: 4%)	N/A	No passenger vehicles were acquired. NREL does not currently have or plan to procure any vehicles classified as passenger vehicles	N/A	N/A
Goal 6: Sustainable Acquisition					
6.1	Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts	N/A	100% of construction contracts meet sustainable acquisitions requirements 100% of custodial contracts meet sustainable acquisitions requirements	Conduct PCard training classes with Q&A sessions Refine green purchase definitions with PCards Continue to require EPPs in contractor and custodial contracts	L—NREL will continue to meet this goal
Goal 7: Pollution Prevention & Waste Reduction					
7.1	Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris	N/A	Diverted 72% of non-hazardous solid waste from the landfill	Develop a plan to achieve higher diversion rates in laboratories	L—NREL will continue to meet this goal
7.2	Divert at least 50% of construction and demolition materials and debris	N/A	Diverted 88% of construction and demolition materials and debris from the landfill	Continue to work with contractors to recycle and reuse construction and demolition waste materials	L—NREL will continue to meet this goal

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SSPP Goal	DOE Goal	Baseline	Performance Status Through FY 2016	Planned Action and Contributions	Risk of Non-attainment: High (H), Medium (M), or Low (L)
Goal 8: Energy Performance Contracts					
8.1	Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693	N/A	NREL will explore using ESPCs, along with other alternative financing mechanisms, but will only pursue economically feasible options. In addition, NREL will continue to utilize other funding options such as REC sales, utility rebates, and in-house savings reinvestment funds.		
Goal 9: Electronic Stewardship					
9.1	Purchases—95% of eligible acquisitions each year are EPEAT-registered products	N/A	99% of eligible electronic acquisitions met EPEAT standards	Continue to uphold best practices for electronic stewardship	L—NREL will continue to meet this goal.
9.2	Power management—100% of eligible PCs, laptops, and monitors have power management enabled	N/A	Power management is enabled on 100% of eligible PCs and laptops	Continue employee education to promote the use of power management throughout the laboratory	L—NREL will continue to meet this goal
9.3	Automatic duplexing—100% of eligible computers and imaging equipment have automatic duplexing enabled	N/A	100% of MFDs have automatic duplexing enabled 100% of eligible personal printers have automatic duplexing enabled	Continue to replace personal printers, scanners, and fax machines with MFDs	L—NREL will continue to meet this goal
9.4	End of Life—100% of used electronics are reused or recycled using environmentally sound disposition options each year	N/A	100% of electronics at their end of life were donated, resold, or recycled using environmentally sound disposition practices. 17,890 pounds of electronics were recycled	Continue to donate, resell, or recycle electronics at their end of life	L—NREL will continue to meet this goal
9.5	Data Center Efficiency—Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers	N/A	The RSF data center had an average PUE of 1.16 The HPC data center had an average PUE of 1.04	Continue to pursue an average PUE below 1.2 in the RSF Data Center Continue to pursue an average PUE below 1.06 in the HPCDC	L—NREL will continue to meet this goal
Goal 10: Climate Change Resilience					
10.1	Update policies to incentivize planning for and addressing the impacts of climate change	N/A	NREL's recent vulnerability assessment and resiliency action plan identified all these goals as resilience options and will pursue these changes in FY 2017 and in the future	Convene the steering committee to review climate change conditions at the laboratory Develop task groups to address recommendations from the Resilience Action Plan Coordinate a regional symposium to identify opportunities for local partnership in climate change resilience planning	L—NREL will address these goals in FY 2017
10.2	Update emergency response procedures and protocols to account for projected climate change, including extreme weather events	N/A			
10.3	Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change	N/A			
10.4	Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies	N/A			
10.5	Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary	N/A			
			NREL's recent vulnerability assessment and resilience action plan utilized current climate science information provided by the Western Water Assessment, our region's Regional Integrated Science and Assessment climate science research team	NREL will continue to utilize current climate science information as planning decisions are made	L—NREL will continue to meet this goal

Greenhouse Gas Reduction

Goals and Achievements

(1.1) 50% Scope 1 & 2 GHG reduction by FY 2025 from a FY 2008 baseline (FY 2016 target: 22%)

- 27,033 MTCO₂e of Scope 1 and 2 emissions, a 13% increase from the baseline without RECs
- 3,415 MTCO₂e of Scope 1 and 2 emissions, an 86% decrease from the baseline including RECs to offset Scope 2 emissions

(1.2) 25% Scope 3 GHG reduction by FY 2025 from a FY 2008 baseline (FY 2016 target: 7%)

- 8,177 MTCO₂e of Scope 3 emissions, a 9% increase from the baseline without RECs
- 6,621 MTCO₂e of Scope 3 emissions, a 12% decrease from the baseline including RECs to offset T&D emissions.

For the 10th consecutive year, NREL won first place in the Bike to Work Day Jefferson County Class D Business Challenge, thanks to the 261 participants. NREL provides bike parking, storage, and showers to encourage employees to bike to work every day!



Greenhouse Gas Reduction

FISCAL YEAR 2016 PERFORMANCE STATUS

The National Renewable Energy Laboratory's (NREL's) operational boundaries include Department of Energy (DOE)-owned facilities, equipment, and the vehicle fleet and non-highway vehicles on both the South Table Mountain (STM) and National Wind Technology Center (NWTC) campuses. NREL has partial lease agreements for office, storage, and laboratory space in the Denver West Office Park, the Joyce Street facility, and the Renewable Fuels and Lubricants Laboratory, which are not under NREL's operational control. Energy data for these properties, however, are included in NREL's greenhouse gas (GHG) emissions as required. Moreover, GHG emissions from DOE's Golden Field Office (DOE GO) operations are captured both within NREL totals and DOE Headquarters totals where appropriate.

As DOE's only national laboratory solely dedicated to researching and developing clean energy and energy efficiency technologies, NREL continues to aggressively leverage its mission to ensure it meets and exceeds sustainability goals. At the same time, NREL maintains state-of-the-art sustainable and resilient campuses for industry and other federal facilities to use as models.

Currently, NREL has three high-energy, mission-specific facilities that pose a challenge to the reduction of Scope 1 and 2 GHG emissions:

- The Energy Systems Integration Facility (ESIF) consumes about 19% of the STM campus total energy consumption (electricity and thermal)

- The Solar Energy Research Facility (SERF) consumes about 17% of the STM campus total energy consumption (electricity and thermal)
- The Field Test Laboratory Building (FTLB) consumes about 15% of the STM campus total energy consumption (electricity and thermal).

Housed in the ESIF is the HPCDC, the most energy-efficient data center in the world, featuring liquid cooling and waste heat capture and reuse. Regardless of these energy-saving features, however, the HPCDC uses a significant amount of electricity, accounting for more than 23% of the total electricity consumed on the STM campus.

NREL's preferred method of offsetting GHG emissions is through onsite production of renewable energy and energy efficiency technologies. NREL will, however, continue to purchase renewable energy certificates (RECs) to supplement onsite renewable energy production. NREL only uses RECs to offset GHG emissions from electricity consumption and transmission and distribution losses.

Scope 1

Scope 1 GHG emission sources include stationary, mobile, fugitive, and process emissions. NREL reduced Scope 1 emissions by 36% from the baseline year to 3,415 metric tons of CO₂ equivalent (MTCO₂e) in FY 2016.

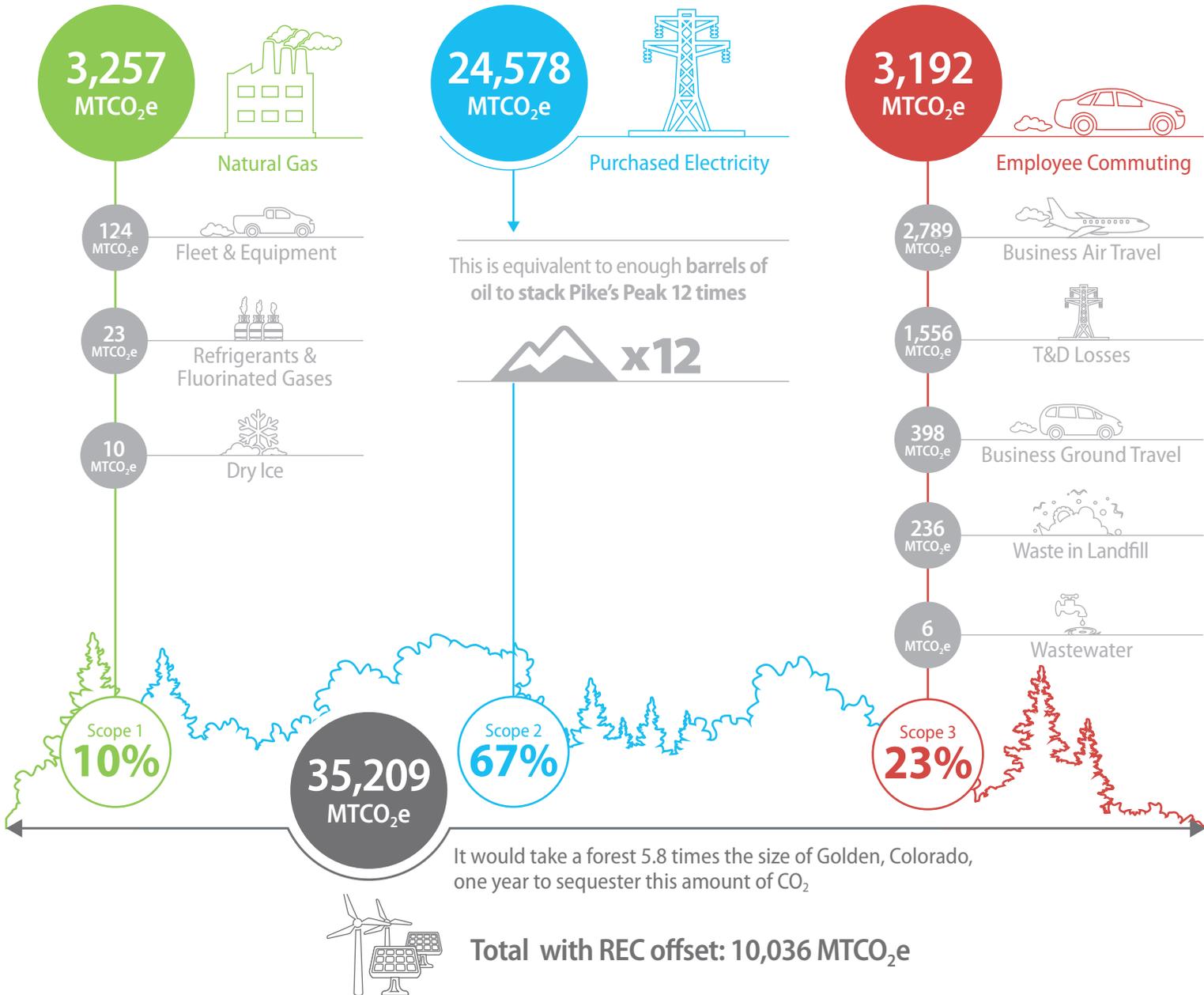
Stationary emissions (natural gas for heating facilities and for experiments) make up 95% of Scope 1 emissions and total 3,257 MTCO₂e. This is a 7% decrease from the baseline year of FY 2008. The winter of 2015–2016 was a comparatively

milder winter overall. This helped to reduce the need for natural gas because NREL's Renewable Fuel Heat Plant (RFHP), which offsets natural gas used for district heating, did not have to be used during for the majority of the past heating season. This was due to physical upgrades to the system as well as NREL's cost-effective practice of using the RFHP only when an extended period of cold temperatures is predicted.

Mobile emissions (vehicle fleet and non-highway vehicles, equipment, and diesel generators) account for 4% of Scope 1 emissions and total 125 MTCO₂e. This is a 49% increase from the baseline year of FY 2008. NREL has reduced petroleum consumption in fleet vehicles by 24% from the baseline year. However, the number of non-fleet vehicles and equipment has increased since the baseline year, causing overall mobile emissions to increase.

Fugitive emissions (fluorinated gases, refrigerants, and onsite septic systems) account for less than 1% (0.7%) of Scope 1 emissions and total 23 MTCO₂e. In FY 2016, fugitive emissions were reduced by 99% from the FY 2008 baseline year. Only 0.5 lbs of sulfur hexafluoride (SF₆) was added to the chemical inventory in FY 2016. NREL continues to utilize a safe and effective program to capture, store, and determine leaks for SF₆. Currently SF₆ is being used for building efficiency testing and dielectric material in some of the transmission electron microscopes. NREL improved processes for tracking refrigerants used in Sustainability, Infrastructure Transformation, and Engineering (SITE) Operations. This new system allows NREL to better record refrigerants

Greenhouse Gas Emissions: FY 2016



that are purchased, in storage, and recycled. Currently, no method is in place to capture the total amount of GHG emissions not released into the atmosphere because of refrigerant recycling. NREL recycles all used refrigerants whenever possible. Tanks are recycled with a United States Environmental Protection Agency (EPA)-Certified Refrigerant Reclaimer to reduce the amount of emissions to negligible levels. NREL regularly monitors equipment that uses refrigerants for leaks to minimize fugitive emissions.

Industrial process emissions account for less than 1% (0.3%) of Scope 1 emissions, which are all emitted from dry ice usage in the laboratories totaling 10 MTCO₂e. This is a 17% increase from the FY 2008 baseline due to the need to meet research demands in the FTLB and SERF. The research staff uses about 700 lbs of dry ice every ten to fourteen days.

Scope 2

NREL's Scope 2 emissions are associated with electricity purchased from its sole electricity provider, Xcel Energy, totaling 23,618 MTCO₂e. This is a 27% increase from the FY 2008 baseline. The HPCDC has continued to grow, which has increased overall electricity consumption on the STM campus. This continued growth leads to an increase in Scope 2 emissions. Committed to ensuring that the laboratory achieves Scope 2 carbon neutrality, NREL purchased Green-e-certified RECs in FY 2016 to offset all Scope 2 emissions that could not be avoided. NREL ensured that all RECs purchased were generated within 10 years of FY 2016.

Scope 3

Scope 3 emissions are associated with transmission and distribution losses from the power grid, business air and ground travel, employee commuting, contracted wastewater,

and solid waste disposal for the campuses. In FY 2016, NREL Scope 3 emissions were reduced by 12% from the FY 2008 baseline year, including RECs to offset T&D emissions to 6,621 MTCO₂e.

T&D losses account for 19% of all Scope 3 emissions sources, totaling 1,556 MTCO₂e. This is a 27% increase from the FY 2008 baseline that is attributed to an overall growth in electricity usage in FY 2016 from the continuous increase in electricity consumption of the HPCDC.

Business air travel accounts for 34% of all Scope 3 emissions, totaling 2,789 MTCO₂e. This is a 33% increase from the FY 2008 baseline year. Although employee air travel is limited to mission-critical activities, increases in population account for continued increases in Scope 3 emissions from business air travel. NREL has extensive teleconferencing and video conferencing capabilities in place to reduce the need for business air travel as much as possible.

Business ground travel accounts for 5% of all Scope 3 emissions, totaling 398 MTCO₂e. This is a 99% increase from the FY 2008 baseline. Although NREL continues to limit business travel to mission-critical activities and promote the use of teleconferencing capabilities, growth in the number of employees contributes to increased business ground travel as well as improved methods of reporting.

Employee commuting accounts for 39% of all Scope 3 emissions, totaling 3,192 MTCO₂e. Despite continued population growth, NREL and DOE Golden Field Office (GO) continue to see decreases in commuting GHG emissions from the FY 2008 baseline. In FY 2016, employees' commuting emissions decreased 12% from the baseline year. This can be directly attributed to a decrease in overall NREL and DOE GO employee commuter miles, a new NREL shuttle route

coordinated between an RTD station and NREL to encourage alternative commuting by transit options, telecommuting and alternative work schedule programs, and employee commuter awareness campaigns. Approximately 19% of NREL employees telecommute at least one day per week, and approximately 25% of NREL employees work an alternative work schedule. Fifty-six percent of DOE GO employees telecommute at least one day per week, and 43% work an alternative work schedule.

In FY 2016, NREL and DOE GO took part in both the pilot year for the regional multimodal month promotional program, DRCOG's GoTober, as well as Colorado Bike to Work Day. For the tenth year in a row, NREL won first place in the Jefferson County Class D Business Challenge thanks to 238 NREL Bike to Work Day participants, with 26 of DOE GO's employees biking into work as well.

Contracted wastewater treatment emissions accounted for less than 1% (0.1%) of all Scope 3 emissions, totaling 6 MTCO₂e. This is 36% higher than the FY 2008 baseline. The values for wastewater treatment emissions are calculated based on population. NREL's population increased from the baseline year and decreased slightly from FY 2015. The DOE's Golden Field Office (GO) population increased from FY 2015. These population changes contributed to increased emissions from contracted wastewater treatment.

Contracted waste disposal emissions accounted for 3% of all solid waste (i.e., waste that goes to the landfill), totaling 236 MTCO₂e. This is a 31% decrease from the FY 2008 baseline. NREL's solid waste reduction and waste diversion measures are resulting in less solid waste and, therefore, fewer waste disposal emissions.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

Reducing Scope 1 emissions involves decreasing stationary, mobile, fugitive, and process emissions. NREL will continue to optimize the RFHP performance to reduce natural gas consumption for the STM campus. During project investigations, NREL determined that the heat recovery system in the SERF and Science & Technology Facility (S&TF) had been piped incorrectly for many years, significantly reducing heat recovery. In FY 2017, NREL will start a project to correct the piping issue. This should result in energy savings from a reduction in natural gas required for heating. If appropriate to the laboratory's mission, NREL will purchase additional alternative fuel vehicles (AFVs) and zero emission vehicles to reduce emissions from its fleet vehicles and will evaluate fleet reduction opportunities annually in light of changing mission requirements. NREL will also investigate new ways to reduce refrigerant emissions. In FY 2017 NREL will replace three existing chillers currently using R-22 with new chillers using R410a. All R-22 in existing chillers will be recovered and recycled with a certified refrigerant recycler. NREL will continue to explore opportunities to substitute current chemicals with alternative chemicals that are less harmful and emit fewer greenhouse gases.

Reducing Scope 2 emissions involves reducing electricity load wherever possible through renewable energy and energy efficiency measures. In FY 2017, NREL will continue the implementation of the Intelligent Campus platform and the SkySpark analytical software to support efforts in energy management and continuous commissioning. It will also help to identify energy efficiency measures that can be implemented in each facility. The HPCDC in the ESIF, however, will continue to grow in capacity, doubling electricity consumption every two years. In FY 2017, demand is estimated to increase and reach 5 MW by 2018 as old equipment is replaced with a new computing system.

To reduce Scope 3 emissions, NREL will continue to work with WaytoGo to promote alternative commuting through the annual GoTober multimodal event. Employees will be invited to join the event and try some form of alternative commuting for at least four days throughout the month of October. The WaytoGo website will provide connections to other carpoolers and vanpoolers and present information about transit options, biking, and walking to work. NREL will continue to explore other methods to effectively disseminate alternative commuting advice to NREL employees, and will continue to promote teleconferencing and video conference services to minimize business ground and air

travel. In FY 2017, NREL plans to conduct a commuter survey for all employees to update information on employee commuting practices.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Begin a project to correct piping in the heat recovery systems in the SERF and S&TF
- Continue energy efficiency improvements to reduce Scope 1 and 2 emissions
- Increase output from the RFHP to reduce Scope 1 stationary emissions
- Replace three chillers currently using R-22 with chillers using R-410a
- Continue to promote teleworking and alternative commuting practices to reduce Scope 3 emissions
- Conduct an employee commuter survey to update employee commuting information
- Reevaluate the *Scope 3 Greenhouse Gas Emission Reduction Plan* to identify other opportunities to reduce Scope 3 emissions.

Energy Use and Metering

Goals and Achievements

(2.1) 25% energy intensity (Btu per GSF) reduction in goal-subject buildings, achieving 2.5% reductions annually, by FY 2025 from a FY 2015 baseline

- Energy use intensity decreased 3% from the baseline to 118,135 Btu/GSF

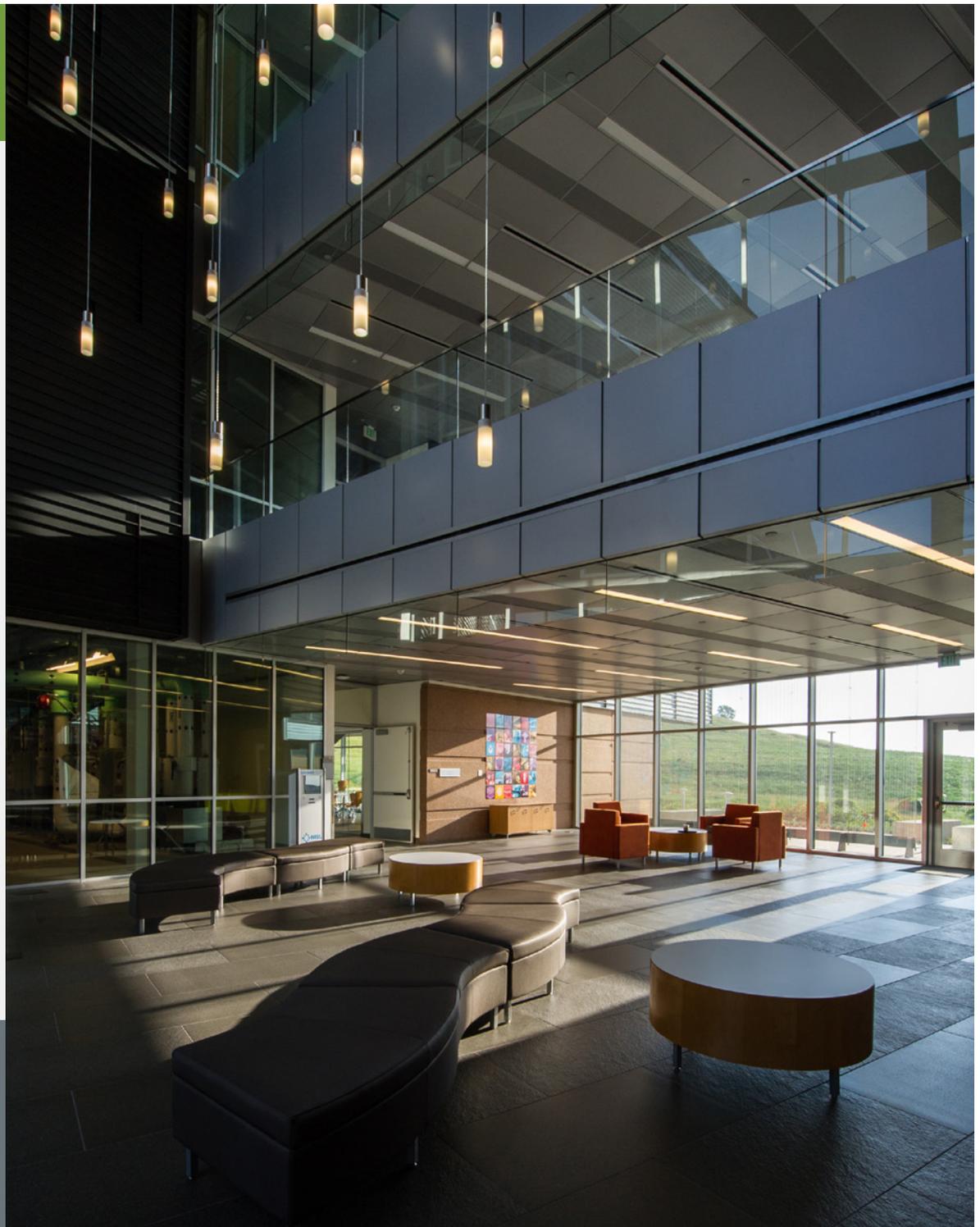
(2.2) EISA Section 432 energy and water evaluations

- Conducted EISA audits on four facilities that use 5% of total energy
- Evaluations are 100% complete for Cycle 2

(2.3) Meter all individual buildings for electricity, natural gas, steam, and water, where cost-effective and appropriate

- 100% of NREL's buildings have energy meters (including electricity, natural gas, and renewables where appropriate)
- 100% of NREL's buildings have chilled water meters
- 100% of NREL's buildings have hot water meters (NREL does not use steam)
- 95% of NREL's buildings have potable water meters.

The Energy Systems Integration Facility (ESIF) employs a number of daylighting and energy efficiency techniques throughout the facility as well as being home to the mission critical High Performance Computing Data Center (HPCDC), the most energy-efficient data center in the world.



Energy Use and Metering

FISCAL YEAR 2016 PERFORMANCE STATUS

The high-performance buildings at NREL incorporate a number of ultra-high energy efficiency and renewable energy technologies, making them models for sustainability. NREL currently has 18 buildings larger than 5,000 GSF. As of FY 2016, six of these facilities were designated LEED® Platinum and one achieved LEED® Gold.

Energy Use Intensity

Energy use intensity at NREL met DOE's goal for FY 2016 with a value of 118,135 British thermal unit per gross square foot (Btu/GSF), which is a 3% decrease from the FY 2015 baseline. NREL excludes fully serviced leases (Denver West Buildings and the Washington, D.C., office) from its energy use intensity calculation. In FY 2016, NREL made the decision to also exclude energy use from the HPCDC. The HPCDC energy use is driven by mission requirements and will increase electrical consumption until it reaches 10 MW of capacity. NREL will continue to explore efforts to ensure that the HPCDC maintains its status as the most energy efficient data center in the world. In addition, NREL plans to offset the HPCDC electricity consumption with renewable energy sources or purchase off-site green power where fiscally feasible in the future. NREL also adjusted the FY 2015 baseline to 121,330 Btu/GSF to reflect this change in excluded facilities.

NREL's *Strategic Energy Management Plan*, which was updated in FY 2016, outlines the laboratory's energy management strategy to

improve energy efficiency at both the STM and NWTC campuses. This document prescribes that NREL reduce its energy footprint by implementing energy efficiency measures in campus facilities, informing occupants about behavioral energy conservation, and installing renewable energy systems to meet presidential EOs and DOE mandates. By applying tactical measures set forth in the laboratory's *Strategic Energy Management Plan*, NREL is working toward meeting these required targets.

Intelligent Campus

NREL's Intelligent Campus (IC) platform collects both historical and real-time data and supports analytics that enhance operational awareness and decision-making with respect to energy use. In FY 2016, the IC development team published an article that was presented at the ACEEE's summer session study in August 2016 about the development of platform requirements and lessons learned in the testing of three prototype systems. To begin platform deployment, 17 STM whole-building meters, five NWTC whole-building meters, and six NWTC wind turbine meters were integrated into the IC platform. The DOE Sustainability Performance Office funding opportunity announcement (SPOFOA) SkySpark project is additionally adding all submeters and defining 7,500 metering data points for the ESIF and FTLB into the platform for metering, monitoring, and verification activities.

The integration of control-system data in the IC platform provides value through portfolio-scale analytics, comprehensive demand

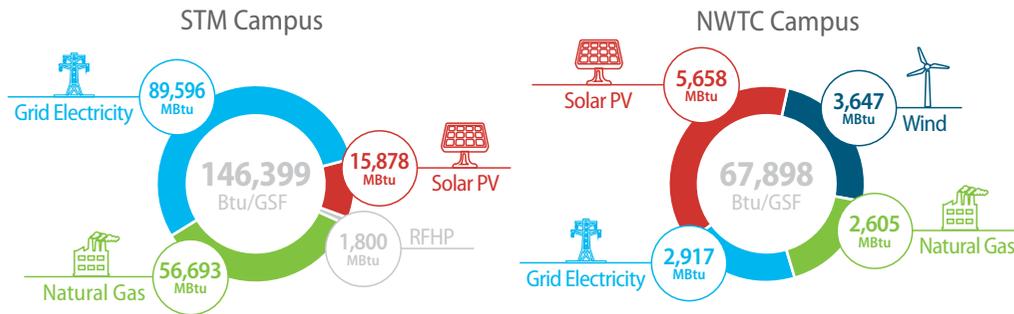
management, and increased visibility of asset performance. Through this platform NREL also has the capability to identify energy savings opportunities and inputs to whole-campus modeling and simulation. The platform will also support the assessment of environmental stewardship performance and bring the ability to automate fast identification and correlation of system problems to support decisions and improvements in system maintenance. NREL studies the adoptions and effectiveness of implemented strategies and technologies in its facilities through the participation of its building occupants. By utilizing the IC program as both an environment and energy informatics platform, NREL fosters situational awareness, engagement, and understanding of energy accountability among laboratory employees and visitors. NREL's IC program, which was developed using open standards and protocols, provides a model that is readily available for transfer to other federal agencies and the private sector.

Energy Management – ISO 50001:2011

DOE's Federal Energy Management Program (FEMP) has recognized NREL's leadership in energy management and aims to establish NREL as a center of excellence for ISO 50001 to assist other federal agencies with attaining certification. In FY 2016, NREL completed both an internal audit and Stage 1 of the ISO 50001:2011 third-party certification. NREL was praised for the structure of its energy management system and the extensive use of energy management tools, data, and analysis in the energy management process.

Energy Intensity: FY 2016

118,135 Btu/GSF
FY 2016 Total Energy Use Intensity



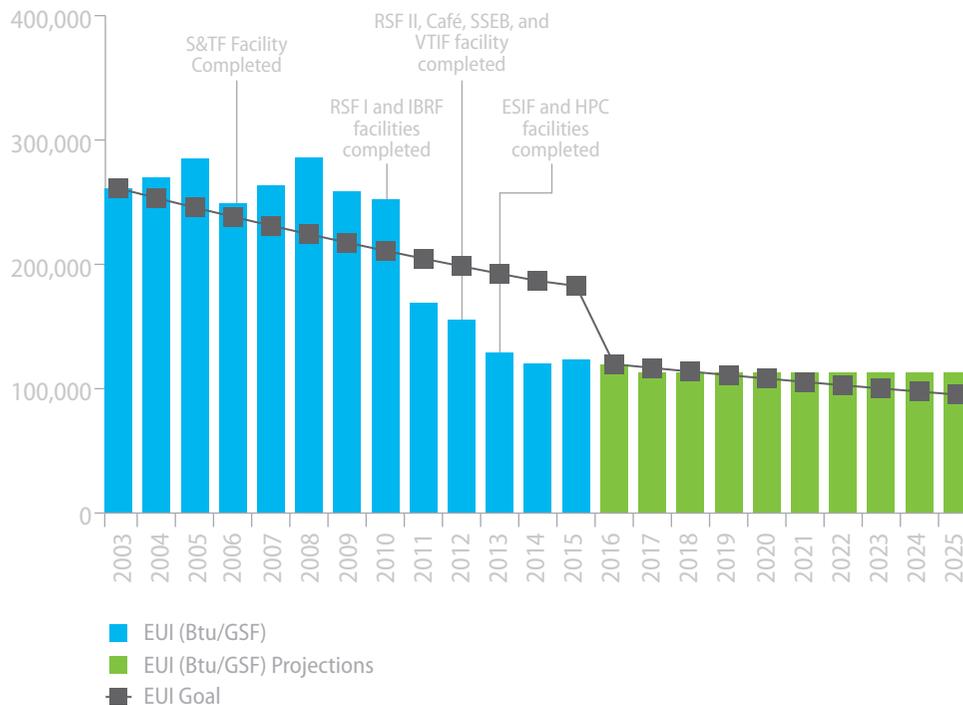
During the Stage 1 audit, six opportunities for improvement were cited, with a strong focus on updating documentation and policies. NREL will continue to refine the lab-wide energy policy and required desk procedures in preparation for Stage 2 of the audit set for April 2017.

In FY 2016, NREL developed a Building Wellness Program to forge stronger collaboration between energy management team members, building operators, and building area engineers to strategize and implement energy efficiency measures in NREL buildings. Teams meet quarterly to discuss building energy targets and key performance indicators, challenges and opportunities, building occupant feedback, equipment needs, and proposed strategies and projects to conduct during the fiscal year.

NREL is actively using the EPA's ENERGY STAR Portfolio Manager to benchmark metered building energy performance on a monthly basis. In FY 2016, NREL worked with Xcel Energy to directly connect natural gas billing to facilities benchmarked in Portfolio Manager. It has not yet incorporated the use of Green Button data from Xcel, but in FY 2016, NREL began using the Power Take-Off tool to directly connect to the main STM electrical meter in order to meter real-time electricity usage on the STM campus.

The Energy Management System (EnMS) is a combination of the IC program and the Sustainable NREL Team's SharePoint data collection and management reporting tool. These programs seek the resources required to monitor and deliver continuous improvement in campus energy performance. The Energy Management Team is composed of individuals who have demonstrated energy competency through their education, training, and experience. The Energy Management

NREL Actual and Projected Energy Use



Team's role is to define, implement, and maintain NREL's EnMS. In addition, the team is responsible for performing energy management activities and developing criteria and methods to ensure effective operation and control of the EnMS. NREL ensures that campus energy professionals receive all training necessary to control significant energy uses and operation of the EnMS. In addition, NREL ensures that these professionals participate in stakeholder workshops to inform activities and behavior that help achieve energy objectives and targets, and to identify the potential consequences of departure from specified procedures. The Energy Management Team also works to disseminate campus energy performance information to all laboratory staff through NREL Now, the laboratory's internal publication. Three Energy Management Team members are certified energy managers and four are licensed Professional Engineers in Colorado.

Energy Metering

Energy meters, which are installed in all of NREL's buildings, track energy consumption and demand including electricity, natural gas, and water usage.

Electricity metering at the laboratory includes advanced electricity meters in all major facilities and on major process loads. All facilities that require water on the STM site have dedicated utility water meters. Chilled water meters and hot water meters (NREL does not use steam) are installed in 100% of NREL's buildings; updating and replacement of these meters began in FY 2016 and will move into FY 2017. All NREL facilities that use natural gas have building-level gas meters. The *NREL Metering Management Plan* (Appendix A) discusses

metering management operating practices in further detail.

To support DOE's metering requirements, NREL's design standards for new and renovated spaces require water submeters at makeup water systems that support mechanical heating, ventilation, and air conditioning (HVAC) equipment and laboratory processes. Design standards also require that meters be installed on chilled water and heated water systems for all new facilities that are tied into the main centralized district heating and cooling plants. An irrigation meter is also required for all newly constructed facilities that use water in the short term to establish new vegetation. NREL in-house maintenance staff members maintain the submeters and record the data they yield each month.

Energy Independence and Security Act Audits

NREL has conducted ASHRAE Level 2 audits for Energy Independence and Security Act (EISA) evaluations on 100% of the NREL facilities covered by EISA Section 432, which defines the facilities under its purview as major energy-consuming facilities with opportunities for energy efficiency improvements. Fiscal year 2016 was the last year of the current four-year cycle.

In FY 2016, energy and water audits were performed at the

- Café
- Integrated Biorefinery Facility
- Research Support Facility II
- South Site Entrance Building.

In-house experts performed the EISA audits, which evaluated lighting, mechanical, heating, cooling, water, and plug-load systems that

comprise 5% of NREL total energy consumption. Despite being new facilities, a small number of energy conservation measures (ECMs) were identified during these audits, mostly related to lighting. NREL has developed an in-house savings reinvestment procedure to potentially help fund the implementation of these ECMs.

Savings Reinvestment Fund

In FY 2016, NREL completed a final draft of an in-house savings reinvestment funding source to promote sustainability at all levels of the laboratory by funding projects that demonstrate sustainability leadership and economic benefit, and also decelerate utility costs. The draft procedure that describes the establishment of the funding source, provides guidelines for selecting projects for funding, and verifies savings is currently pending approval. Once the procedure is approved, seed funds will be used for a set of energy and water efficiency projects that will help replenish the funds for future sustainability projects.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL's energy footprint continues to expand, primarily because of increased population and computational activities from both the HPCDC at the ESIF and the data center at the RSF.

The laboratory will continue to seek ways to reduce energy use intensity on campus through site design and building development that maximizes energy and water efficiency as well as renewable energy opportunities. NREL uses advanced metering data, the Building Wellness Program, and energy and water audits to ensure the highest efficiency and best use of resources throughout its facilities.

The core of NREL's strategic energy management approach is to consistently incorporate energy management into central practices and decision making, such as strategic planning and budgeting processes. In FY 2017, NREL will conduct a workshop with the NREL Leadership Team to review and discuss any modifications to short- and long-term objectives and targets captured in the Strategic Energy Management Plan.

NREL will continue analytic development tasks for the IC in FY 2017 for use in dashboards, fault detection and diagnostics, and peak shaving algorithms. As part of fault detection diagnostic activities, rules are being written for performance equipment thresholds that

will continually identify operational issues 24 hours per day every day for both the ESIF and FTLB. A retrocommissioning project in the FTLB will be completed in FY 2017 and data information collected for the FTLB through the IC will be submitted to Xcel, NREL's electricity utility provider, as part of its energy rebate program. In addition, NREL is planning campus demonstrations of projects utilizing renewables and small storage batteries to investigate implementation of power demand management strategies. In order to expand collaboration efforts, diverse content workshops will be conducted with researchers that focus on the strategy and technology development in energy informatics.

MEASURABLE GOALS

In FY 2017, NREL will:

- Attain third-party certification of ISO 50001
- Add the STM campus submeter to the IC platform in order to develop control algorithms for peak shaving capabilities
- Start the next cycle of EISA audits on five facilities
- Approve and implement a savings reinvestment fund.

High-Performance Sustainable Buildings

Goals and Achievements

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

- Six buildings (33%) of eligible buildings are compliant with the Guiding Principles

(2.6a) Net Zero Buildings: 1% of the site's existing buildings above 5,000 GSF intended to be energy, waste, or water net zero buildings by FY 2025

- One building (5%) of eligible buildings is net zero energy

(2.6b) Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net zero beginning in FY 2020

- All new NREL buildings entering the planning process will be designed to achieve energy net zero where feasible.

The Research Support Facility (RSF) was designed as a net zero energy office building. Since January of 2016 the building has been operating at a net zero energy capacity thanks to the 2.5 MW of solar PV on the both the building rooftop and the surrounding parking garage areas.



High-Performance Sustainable Buildings

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL is committed to the design, operation, and maintenance of high-performance sustainable buildings (HPSB) on its campuses by employing building design and operation strategies that promote optimal performance and maximize life-cycle asset value.

NREL currently has 18 buildings larger than 5,000 GSF that make up the candidate pool for the revised Guiding Principles for HPSB. As of FY 2016, six of these buildings met 100% of the 2008 Guiding Principles for HPSB: the S&TF, the RSF I and II, the Integrated Biorefinery Research Facility, the Café, and the ESIF. In FY 2015, these facilities were included in an NREL climate change vulnerability assessment and resiliency action plan assessment. With these six buildings, NREL is currently 33% compliant with the 2016 revised Guiding Principles.

Guiding Principles

NREL uses the EPA's ENERGY STAR Portfolio Manager to assess and manage Guiding Principles for HPSB compliance. All checklists, with supporting documentation, are maintained in this tool and are used to ensure that the Facilities Information Management System sustainability fields are accurate. NREL has not yet had the opportunity to assess facilities under the revised Guiding Principles criteria. The 33% of NREL's eligible buildings in full compliance met the 2008 Guiding Principles before the revision and, based on those assessments, meet the revised Guiding Principles. NREL will assess the remaining 67% of facilities under the revised

Guiding Principles and strategize the possibility of bringing 100% of facilities into compliance. In addition, NREL building systems and material performance requirements for all new buildings meet the revised Guiding Principles and are integrated into construction cost estimates.

Leadership in Energy and Environmental Design Certification

NREL is committed to pursuing LEED® Gold or higher certification to the extent possible for all new construction on the STM and NWTC campuses as well as ensuring that all new construction at NREL will be fully compliant with the Guiding Principles for HPSB.

As part of this pursuit, NREL incorporates energy efficiency features in building design, resulting in performance that far exceeds ASHRAE standards. NREL ensures that all new construction is designed to be 30% more energy efficient than the baseline established by ANSI/ASHRAE/IESNA Standard 90.1 2010. NREL also incorporates onsite renewable energy generation to support the operation of net zero energy buildings. In an effort to uphold EO 13693, NREL is working toward the goal of net zero energy performance for all new buildings.

New Facilities

NREL proposed three possible new construction line item facilities in FY 2016, including the Clean Energy Materials and Processing Innovation Lab (CEMPIL), a new wind energy research laboratory, and the Clean Energy Design and Collaboration Center. Where feasible, NREL will pursue energy net zero design for these buildings.

Net Zero Buildings

Two buildings on the NREL campus were designed to be energy net zero facilities: the RSF and the South Site Entrance Building (SSEB). The RSF building began operating at net zero in January 2016. The building showcases numerous high-performance design features, passive energy strategies, and renewable energy technologies. Solar panels on the parking garage and the visitor's parking lot add to the solar photovoltaics (PV) installed on the RSF rooftop to offset RSF grid electricity consumption. The panels also help offset the energy used by the parking garage's 36 electric vehicle charging stations. NREL's SSEB is a highly efficient and small facility (under 1,700 ft²). It has the same types of daylighting and occupancy sensors as the RSF, a wind catch tower for natural ventilation, and geothermal heating and cooling.

NREL demonstrates leadership in the net zero arena by publishing building sector definitions for the concept of a net zero energy building and by constructing and operating such facilities. This requirement is included in the scope of work and construction specifications for all new facilities.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL will continue to take steps to bring all 100% of its facilities into full compliance with the revised Guiding Principles for HPSB. In FY 2017, NREL will develop a plan to assess the remaining 10 eligible facilities. In addition, NREL will collaborate with researchers in the ESIF to monitor office desktop equipment and

Success Story

RSF ACHIEVES ENERGY NET ZERO

In January 2016, the RSF began operating as a net zero energy facility and continued to through the end of FY 2016. In January the 12-month rolling average energy use intensity of the facility was -2 kBtu/GSF using a source net zero B calculation. In September of 2016 the average energy intensity was -10 kBtu/GSF. The phenomenal performance of the RSF can be attributed to a number of factors including the robust production and systems enhancements of the on-site solar PV systems, and the enormous

reduction in load from the RSF data center. The continued support of stakeholders, building operators, and occupants has also contributed to this achievement. During the EISA audit of the RSF II, NREL identified a number of lighting ECMs that could contribute to further reductions in electrical load in the building. NREL will continue to partner with occupants, researchers, and building operators to improve the performance of the RSF and maintain its operation as a net zero energy facility.

critical laboratory research equipment with high energy process loads in order to create a guide of best management practices. The IC platform will continue to be deployed to campus facilities with real-time data so building occupants can better understand energy consumption of all building systems.

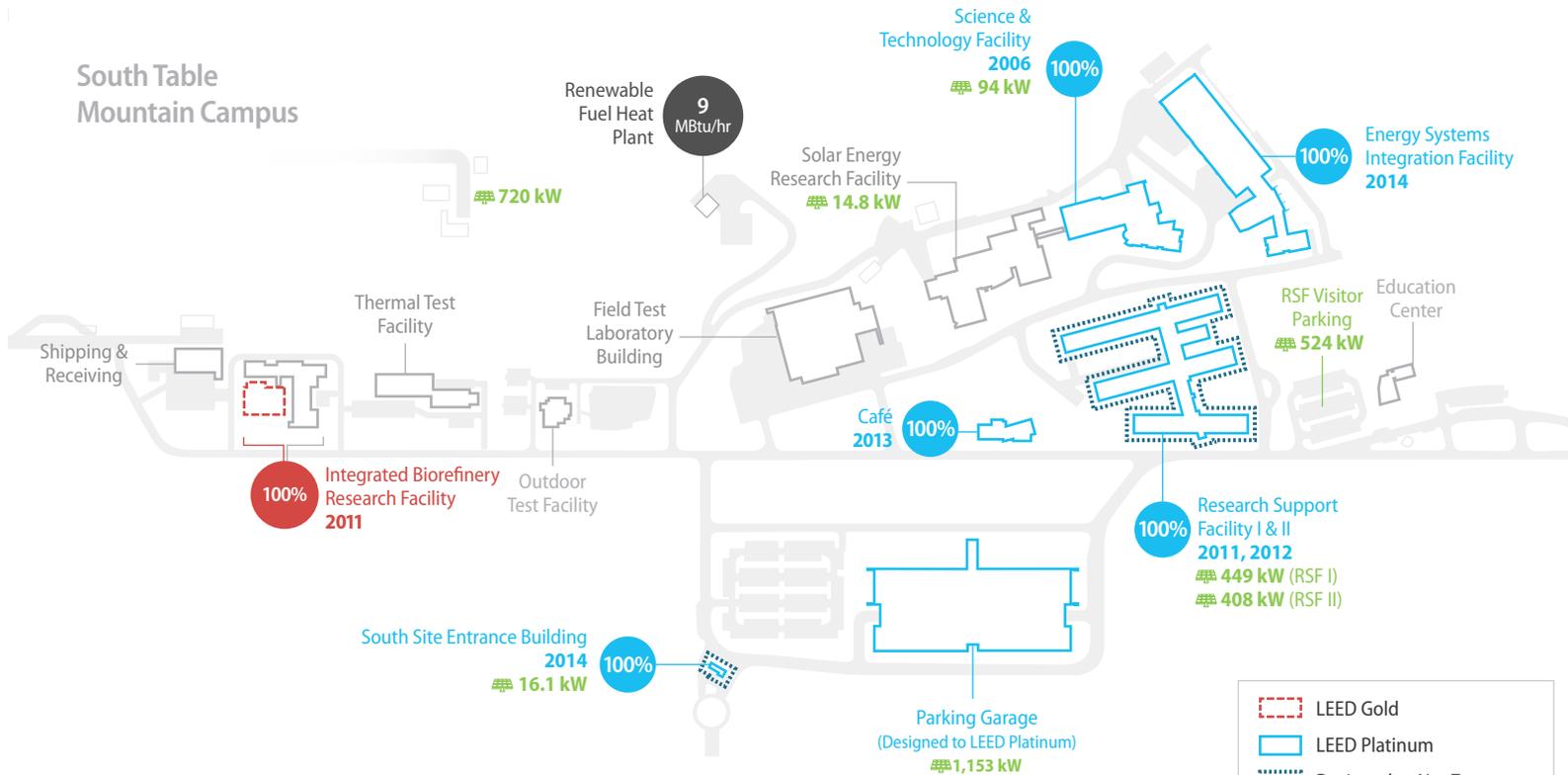
As NREL expands the campus footprint, the laboratory is committed to building high-performance sustainable facilities that are net zero energy and, if feasible, net zero waste or water.

MEASUREABLE GOALS

In FY 2017 NREL will:

- Pursue opportunities to integrate ECMs within existing facilities for expanded building portfolio compliance with the revised Guiding Principles for HPSB
- Assess five buildings for their compliance with the revised Guiding Principles for HPSB
- Integrate rooftop PV arrays into cost and construction planning for new facilities.

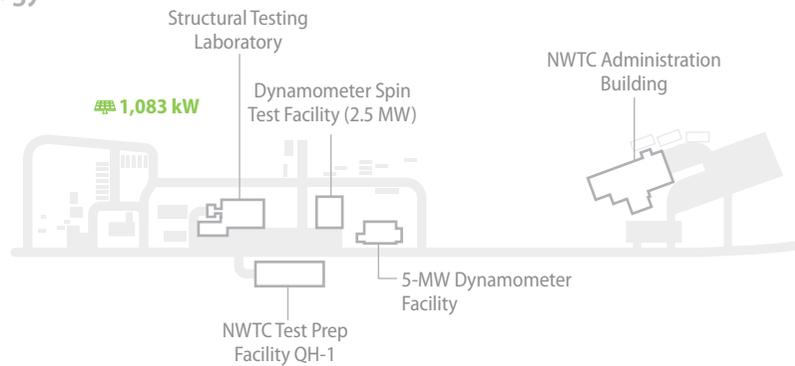
High-Performance Sustainable Buildings: FY 2016



- LEED Gold
- LEED Platinum
- Designed to Net Zero
- Guiding Principles for HPSB
- Solar PV capacity
- Wind capacity

National Wind Technology Center Campus

- † 1.4 MW (Research Turbines)
- † 1.5 MW (GE/DOE Turbine)
- † 2.3 MW (Siemens Turbine)
- † 3.0 MW (Alstom Turbine)
- † 2.0 MW (Gamesa Turbine)



Regional and Local Planning

Goals and Achievements

(2.5) Efforts to increase regional and local planning coordination and involvement

- Supported City of Lakewood efforts to install a new bike lane near the entrance of the STM campus
- Advocated with RTD to bring additional bus route service to the STM campus
- Participated in DRCOG's GoTober multi-modal month
- Developed and implemented improvements to the NEPA process with DOE GO partnership
- Monitored local bat populations with Rocky Flats National Wildlife Refuge.

Fringed Myotis, *Myotis thysanodes*, captured during mist netting on the Rocky Flats Wildlife Refuge.



Regional and Local Planning

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL is actively involved in strengthening the vitality and livability on its campuses as well as in the city of Golden and surrounding communities in Jefferson and Boulder counties. All campus projects include work to integrate physical boundaries, connect to transportation and utility systems, and protect the ecosystem and open space. These initiatives nurture a sustainability culture and forge stronger community, neighbor, and user relationships.

Transportation Planning

NREL's transportation program helps to manage traffic, reduce GHG emissions, and improve air quality by employing a tiered trip strategy. The approach first provides options for employees enabling them to avoid trips (i.e., teleworking and teleconferencing), then to shift the remaining trips to more efficient forms of transportation (i.e., ridesharing, transit, bicycle), and lastly to improve the remaining trips by supporting the use of cleaner technologies (i.e., incentive parking for green vehicles). In FY 2016, NREL won the Denver Region Clean Cities award for largest GHG reducer for its work with alternative fuels and vehicle-miles-travelled reduction strategies.

Cycling is popular in Colorado. With hundreds of miles of bike paths and more than 300 days of sunshine a year, NREL employees are turning to biking as a more cost-effective, environmentally friendly mode of transportation. In FY 2016, NREL:

- Continued partnership with the City of Golden, which opened a Bike Library program in 2016 that allows users to check out bikes and return them after their use to the same location. NREL will continue to look for expansion opportunities around bike sharing.
- Supported the City of Lakewood's efforts to implement a new bike lane on the main road leading to NREL's STM campus. The new bike lane provides safer access for bicycle commuters to NREL and improves east/west bicycle travel for recreational cyclists and bike commuters from the City of Golden, Jefferson County, and the City of Lakewood.
- Participated in DRCOG's Bike to Work Day and won the Business Challenge in the Class D category for Jefferson County.

Ridesharing and public transit options are also a big part of the sustainable culture at NREL and in the surrounding communities. NREL is dynamically involved with regional transportation planning efforts, working with Jefferson County, the City of Lakewood, the City of Golden, Boulder County, and RTD to support transportation decision making in the west Denver metro area. In FY 2016, NREL:

- Advocated with RTD to develop a new bus route that will serve NREL's STM campus and connect employees to transit to the east and north of the campus. This route is planned to be operational in 2017.
- Worked with RTD and MV Transportation to operate a new shuttle service that connects at the RTD Oak St. light rail station. This shuttle

has been a success and overall ridership on NREL's commuter shuttles (providing connections to RTD stations and transfers centers) continues to increase.

- Collaborated with First Bank, a nearby business, to explore the option of sharing shuttle services to the Oak Street light rail station. While sharing was not pursued (First Bank's large staff would have overwhelmed NREL's current shuttles) this gave NREL the opportunity to develop a relationship with local business owners to mentor them through various transportation demand management strategies for their sustainability and operational goals.
- Continued advocacy efforts and construction of bicycle and pedestrian-supportive infrastructure at NREL and throughout the community
- Participated in the Denver Sustainability Summit meeting with regional partners to share ideas about best practices, provide technical expertise, and help craft commitments from participants in support of Denver's sustainability goals in transportation, energy, and waste management
- Participated in DRCOG's GoTober event in October 2015. The pilot program focused on promoting a "multimodal" month-long campaign that included walking, biking, carpooling, vanpooling, transit options, and telecommuting. NREL had 50 participants totaling 21,772 miles of alternative commuting.

Success Story

NEPA PROCESS IMPROVEMENT

The National Environmental Policy Act (NEPA) is an interdisciplinary approach to federal project planning and decision making, requiring federal agencies to consider environmental values alongside technical and economic considerations. As a DOE owned and funded facility, NREL is required to submit all activities and proposed projects for NEPA review before funding is expended or activities begun. The review, which includes an analysis of the proposed activities and their potential for environmental impacts, is a tool to assist the decision makers in making informed decisions. Several levels of reviews include determining whether the activity fits within a DOE categorical exclusion (a class of actions determined to have no significant individual or cumulative effects on the human environment). If the activity does require a more rigorous analysis, an Environmental Assessment or an Environmental Impact Statement is prepared. In order to streamline the NEPA review process, DOE GO and NREL implemented enhancements to the NEPA program, which has increased efficiencies, dramatically reduced review time, and improved documentation of compliance.

Environmental Management and Planning

NREL collaborated with Jefferson County and the facility manager of the Colorado State Highway Patrol Driving Track within the Colorado Division of Central Services and the Colorado State Highway Patrol in FY 2016 to coordinate control and treatments of knapweed. Through this collaboration, NREL was able to determine that the Colorado State Highway Patrol Driving Track, which shares space contiguous to the STM campus, has similar schedules to NREL for annual treatment of knapweed. The group also discussed a plan to alert landowners in areas to the west of the STM campus about methods to control knapweed.

NREL also worked with Rocky Flats National Wildlife Refuge to monitor bat populations both at the Refuge and the NWTC. In doing so, NREL documented six species of bats, capturing 27 individuals in three trapping efforts. Although five of the species were bats previously recorded using acoustic recorders, only through capture can the occurrence of some species be confirmed. This collaborative effort with the Rocky Flats National Wildlife Refuge confirmed the species present at NWTC and the northern half of the refuge including the Eastern Red Bat, which had only been suspected to occur in the area.

In FY 2014, 6,700 ft² of glass windows in the ESIF were retrofitted with a laminate to improve the visibility of the windows to birds, with the goal of reducing bird-window collisions, a leading cause of mortality for birds. Surveys to test the effectiveness of the ESIF window retrofit were completed in FY 2016. To date, no known mortalities have occurred on retrofitted windows.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL will continue to participate in regional and local planning efforts in order to contribute to the social, environmental, and economic success of the region. In FY 2017, NREL plans to reach out to the City of Lakewood, Jefferson County, and others to explore the feasibility of implementing a bikeshare program to enable employees to move between the STM campus and the Denver West Office Park. NREL's culture plays a big role in sustainability, not only on campus but in the surrounding communities where employees live and play.

NREL will continue to provide and participate in outreach activities to communicate sustainable options and ideas to NREL employees, community groups, and regional partners.

MEASUREABLE GOALS

In FY 2017, NREL will

- Conduct an employee commuter survey to update data on employee commuting practices
- Advocate and support the opening of new RTD bus and light rail services in the region
- Continue monitoring and addressing discoveries within the conservation areas at STM and NWTC campuses that require management actions
- Treat more remote noxious weed patches at the STM campus
- Actively monitor the STM conservation easement wildland fire burn area for erosion and habitat loss, and reseed the area if warranted
- Continue efforts to advocate for and improve access to alternative commuting options through regional and local organizations
- Continue participation in regional events promoting alternative transportation such as GoTober and Bike to Work Day.

Clean and Renewable Energy

Goals and Achievements

(3.1) “Clean Energy” requires that the percentage of an agency’s total electric and thermal energy accounted for by renewable and alternative energy shall be not less than 10% in FY 2016-2017, working towards 25% by FY 2025

- Clean energy including RECs accounted for 93% of total electric consumption
- On-site clean energy consumed at NREL accounted for 15% of total energy consumption

(3.2) “Renewable Electric Energy” requires that renewable electric energy account for not less than 10% of a total agency electric consumption in FY16-17, working toward 30% of total agency electric consumption by FY 2025

- Renewable electric energy including RECs accounted for 139% of total electric consumption
- On-site renewable electric energy consumed at NREL accounted for 21% of total electric consumption.

Wind turbines at the National Wind Technology Center (NWTC) leverage cooperative research and development agreement (CRADA) partnerships in order to test wind technology.



Clean and Renewable Energy

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL serves as both a living model of sustainability and a place to develop new clean energy ideas, technologies, and practices. The laboratory strategically employs progressive energy-efficient technologies, renewable energy systems, and REC purchases to continuously improve campus sustainability and resilience.

In FY 2016, clean energy generated from onsite wind and solar sources and NREL's RFHP accounted for 14% of total site energy use. Renewable electric energy generated onsite from wind and solar accounted for 23% of total electric consumption. Furthermore, NREL supplemented onsite renewables with RECs to attain Scope 2 carbon neutrality and support the renewables marketplace. With DOE's FY 2016 clean energy and renewable electric energy goals both at 10% and FY 2025 final target goals at 25% and 30%, respectively, NREL has met FY 2016 requirements.

Solar Photovoltaics

At the end of FY 2015, 12 solar PV panels were installed on the rooftop of the SSEB. In FY 2016, new electrical subpanels and meters were also installed to resolve code issues and provide a single point of disconnect for the entire solar PV system. Even after these upgrades were implemented there remains data system validation issues in the meter readings that NREL will address in FY 2017.

In FY 2016, NREL was awarded a \$500,000 SPOFOA to reduce the price per kilowatt of a

power purchase agreement (PPA) for proposed multiple new solar PV arrays, with the collective capacity ranging between 1.2 MW and 1.6 MW. NREL, DOE GO, and the Western Area Power Administration collaborated on the project contract language and scope of work. While several locations on the STM campus were identified for the project, NREL and DOE GO executive management determined this real estate should be preserved for future construction of NREL mission facilities. Unfortunately, with only rooftops available on existing buildings, the project reduced in scope to less than 400 kW. As a result, the reduced project scale would not have created enough interest by third-party vendors nor would it have been cost effective, therefore the project was canceled.

Wind

Three of the four utility-scale turbines installed at the NWTC are operated by various manufacturers under either a cooperative research and development agreement (CRADA) or a strategic partnership project agreement. Power generated from these turbines is transmitted directly to the grid and not consumed by NREL. The fourth utility-scale turbine is a DOE-installed 1.5-MW General Electric (GE) turbine that, together with other smaller and mid-size research turbines, generated 1,069 MWh of electricity in FY 2016.

The NWTC has an allowable interconnection cap of 10 MW with Xcel Energy. The utility-scale turbines were in operation for a significant part of the year and the GE/DOE turbine had to be routinely curtailed to ensure that the 10-MW

limit was not surpassed. Negotiations for a new interconnection agreement are currently being negotiated with Xcel along with a project to upgrade distribution transmission voltage and build a new substation.

Thermal

The RFHP, NREL's onsite thermal installation, is a sustainable and efficient source of heat for more than 945,000 ft² of laboratory and office space through NREL's district heating system. The RFHP is essentially a boiler that burns wood chips, displacing natural gas for heating throughout the cooler months of the year. In FY 2016 the combustor and ash removal system was upgraded to improve the output of the system. Onsite thermal energy generated from the RFHP in FY 2016 offset 3% of NREL's natural gas demands and 4% of the STM site's district heating demands. These percentages were significantly lower than past performance due to the upgrades required to the system that delayed operations, a mild 2015–2016 winter season, and continued blockages in the ash take-away augers, which were replaced with a conveyor system.

Renewable Energy Credits

NREL purchased RECs through an interagency agreement with Western Area Power Administration to attain Scope 2 carbon neutrality and to support additionality in the renewables marketplace. The RECs purchased under this agreement are from renewable energy projects installed within the past ten years and from eGRID (Emissions and Generation Resource Integrated Database) regions with solar radiance

values comparable or representative of NREL's regional area solar radiance attributes.

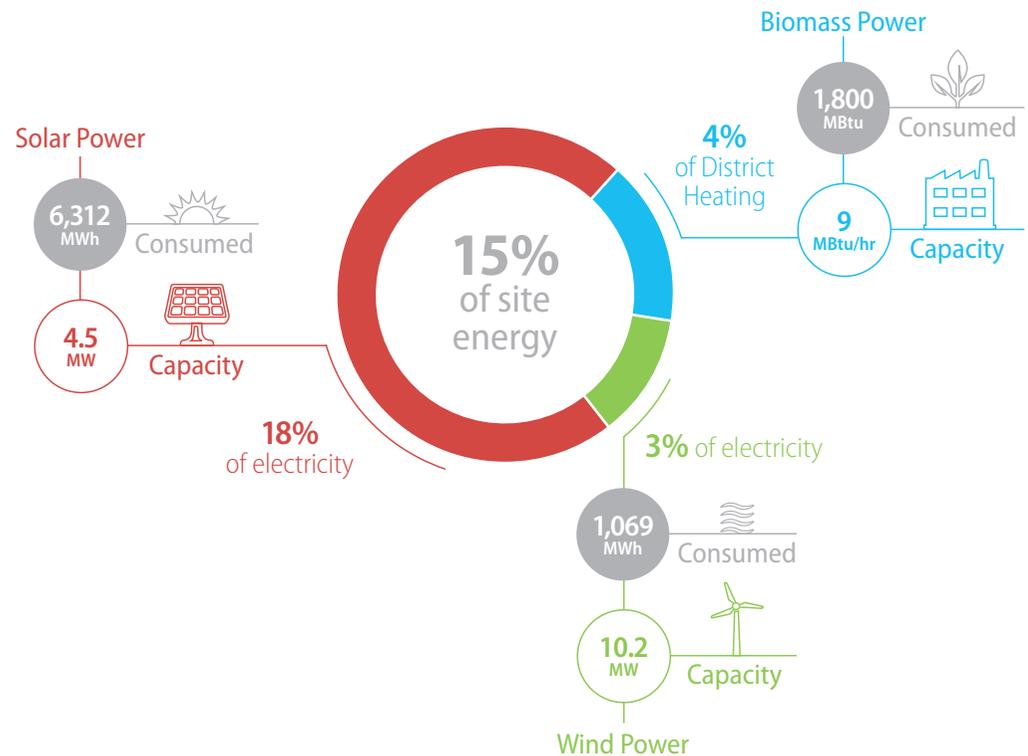
NREL retains the RECs from several smaller and mid-size research wind turbines installed at the NWTC and from the GE/DOE wind turbine. The laboratory also purchased RECs from two of the utility-scale turbines under CRADAs. RECs from some of these turbines are sold to Xcel Energy to support the state of Colorado's renewable portfolio standard. Since NREL operates in a regulated utility market, the lab is precluded from buying grid power from sources other than Xcel Energy/Public Service Company of Colorado.

Currently, NREL does not purchase any electricity, energy products, or energy byproducts directly from Indian Tribes. NREL has explored purchasing renewable energy products from Indian Tribes in the past but found that the distance of the electric distribution systems made it physically impossible to transmit the electricity to NREL. NREL's 2017 REC contract incorporated a preference for energy byproducts produced by tribal-majority-owned business organizations but received no solicitations from those organizations.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

As part of the operational objectives and targets for energy management identified in the Strategic Energy Management Plan (SEMP), NREL's long-term goal is to operate as a net zero energy campus. In addition, on an annual basis NREL reviews its renewables master plan to identify potential projects utilizing diverse funding vehicles such as a PPA, FOA, general plant projects (GPP), or NREL's energy savings reinvestment fund. In the short-term, existing facility rooftops will be prioritized for solar PV installations. Additionally, NREL intends to

Onsite Renewable Energy Portfolio: FY 2016



fulfill this long-term commitment to a net zero energy campus by integrating new solar PV systems with all new construction.

NREL researchers implement strategies and technologies in campus facilities and study first-hand the adoption and effectiveness of those technologies. In particular, NREL transportation researchers have combined battery storage with the parking garage PV array to offset peak demand use of the electric vehicle charging stations. In FY 2017, SITE Operations will apply these control algorithms created by the transportation project together with campus PV arrays and a recently acquired 30-kW battery to investigate peak shaving. By looking beyond

the singular use of generation, NREL is pushing the functional boundaries for other applications of renewable energy for its vital role in power demand management that can reduce ratchet tariff increases in monthly utility bills.

The current electrical generation capacity at the NWTC is 10.2 MW, but turbine operations are being curtailed to stay below an existing 10-MW generation limit in accordance with the interconnection agreement with Xcel Energy. NREL plans to upgrade existing onsite electrical infrastructure and add an interconnection to the local utility, including a new higher-voltage electrical service (transmission) to accommodate a total of 50 MW of onsite electrical generation

capacity. The updated electrical system will be built for 50 MW of capacity, but operated only as 20 MW to stay under the North American Electric Reliability Corporation reporting requirements. When required to operate the system at a higher capacity, the system can be increased to 50 MW by a paperwork process instead of construction. Plans in place to expand the electrical service infrastructure at NWTC could allow for greater production but will not be fully operational before 2018.

NREL will continue to displace natural gas used for building heat by utilizing the RFHP to its fullest extent. Due to the upgrades to

the combustor and ash removal completed in FY 2016, NREL expects to see increased performance from the system in FY 2017, potentially a doubling of previous performance over the past few years.

NREL's preferred method of offsetting GHG emissions is through onsite production of renewable energy. However, contracts will continue to be in place to purchase RECs to meet federal goals. NREL will also continue to work with the General Services Administration (GSA) Region 8 Federal Working Group on the sourcing of large renewable project options to make it possible for federal organizations lacking

real estate and financing for onsite renewable projects to purchase offsite renewables to offset their energy usage.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Continue collaboration with federal GSA Region 8 partners to research options for large renewable energy products
- Increase the thermal output of the RFHP by 50%
- Supplement onsite renewables with REC purchases, as necessary.

Water Use Efficiency and Management

Goals and Achievements

(4.1) 36% potable water intensity (gal per GSF) reduction by FY 2025 from a FY 2007 baseline (FY 2016 target: 18%)

- Potable water intensity reduced 43% from the baseline to 15.6 gal/GSF

(4.2) 30% water consumption (gal) reduction of ILA water by FY 2025 from a FY 2010 baseline (FY 2016 target: 12%)

- NREL does not use ILA water.

Outside the RSF, flowers bloom early spring. NREL uses low water consumption strategies by using local plants, xeriscaping, and innovative watering techniques using the WeatherTRAK system.



Waste Use Efficiency and Management

FISCAL YEAR 2016 PERFORMANCE STATUS

Given the many connections between energy and water, NREL fully understands how critical water use efficiency and management is to the resilience of the laboratory's energy system.

Since 2010, aggressive water efficiency and conservation measures at NREL have consistently resulted in lower water use intensity than DOE's target goal. In FY 2016, NREL's water use intensity was 15.6 gal/GSF, which is 43% lower than the FY 2007 baseline and lower than the target goal of a 36% reduction. NREL does not use industrial, landscaping, and agricultural (ILA) water.

Water at NREL's STM site is supplied by Consolidated Mutual Water Company. All facilities on the STM campus have water meters, with submeters on high-intensity water devices such as evaporative coolers, deionized water, closed loop makeup water, irrigation, and autoclaves.

The NWTC site is remote and has no wells or municipal water supply. Water is delivered to the NWTC weekly, stored onsite in a 15,000 gal underground storage tank, and pumped on demand to a 2,000 gal aboveground storage tank. The 2,000 gal tank is used as the source to distribute water as needed to NWTC facilities.

Current Colorado state water laws limit the onsite collection of rainwater and reuse of storm water and gray water sources, and no municipal reuse water lines are located near either campus.

Major water-consuming end use consists of cooling, laboratory equipment, domestic use

for sinks and sanitation, and irrigation. In FY 2015, end-use water consumption at NREL was as follows:

- Cooling towers—36%
- Direct evaporative coolers—5%
- Laboratory deionized water—4%
- Other inside use—5%
- Irrigation—2%
- Unclassified (indoor plumbing not on sub-meters)—48%.

Water Use Efficiency

NREL initially began investigating a project in FY 2016 to increase water softener in cooling towers to reduce overall water consumption. However, it was determined that this process would increase cooling tower particulate emissions above reportable limits, so funds for the water softening project were diverted to a reverse osmosis water reuse project to be completed in FY 2017. NREL developed recommendations for future funding needs and building retrofit projects targeted at reducing campus potable water use. Designs are underway and awaiting funding to replace the 30-year-old air handlers in the FTLB with more high-efficiency units. These units will reduce simultaneous heating and cooling, which will in turn reduce cooling tower water use during the heating season.

Johnson Controls, Inc. donated a thermosyphon cooler for NREL to install as a pilot project in the HPCDC at the ESIF in FY 2016. This device rejects most of the HPCDC heat without evaporating water in cool weather. At 50° F outdoor air

temperature it can reject 1,000 kW of heat. Because Denver's mean temperature is 48° F, the thermosyphon can conceivably all but eliminate HPCDC cooling tower water use for half the year. This is very important considering that the HPCDC used 19% of all STM water in FY 2016. In the first few weeks the project had already saved more than 30,000 gallons of water. The pilot will continue into FY 2017. If its performance demonstrates continuous sustained results, this technology will be integrated into other applicable STM facilities.

Water Management

NREL completed an update to its *Water Management Plan* in FY 2016 (see Appendix D). The plan accounts for new water provisions from EO 13693 and tactical measures for efficient water use across the campuses. In addition, NREL completed a water balance analysis for the STM campus to better understand equipment and processes with high water use, improved leak detection, and identification of water conservation measures.

NREL installed HydroPoint WeatherTRAK in 2011 to manage water conservation for landscape irrigation. Since then, campus facilities have expanded greatly and restoration of additional areas have begun. NREL is working to conserve and optimize water efficiency for campus irrigation by using the WeatherTRAK smart irrigation system to automatically adjust landscape watering based on plant needs and daily local weather conditions. Irrigation systems use moisture sensors and run only when necessary. After plants become established,

WeatherTRAK systems monitor soil moisture content and respond when supplemental water is required above natural precipitation delivered in any given season. In FY 2016, NREL did not use the irrigation system during the summer months because some systems were broken and only used a small amount of irrigated water in October 2015 and the late summer months through September 2016.

In FY 2016, NREL conducted EISA water audits on three of NREL's buildings but no water conservation measures were identified. Although not part of the EISA audits, NREL did identify a leak in an FTLB evaporative cooler drain valve through submetering. Fixing the leak reduced monthly water consumption by 90,000 gallons in the first month.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

Construction of the S&TF clean room will be complete in FY 2017. One of the features of the

clean room is an ultra-pure water system to reduce or eliminate dissolved and suspended solids and gases, biological organisms, and organic carbon. This system is projected to use a substantial amount of water. Colorado water law restricts water reuse; however, using reverse osmosis backwash water for cooling tower makeup water is allowed. NREL is collaborating with the water-equipment vendor to divert reverse osmosis backwash water to a holding tank for use as cooling tower makeup water. Although overall water use is expected to increase, this measure will mitigate increases.

NREL will conduct a comprehensive review of the WeatherTRAK system coverage in FY 2017 to ensure that weather-sensing irrigation controls are programmed to properly attain reductions in outdoor potable water use. In addition, this will align with NREL's *Sustainable Infrastructure Master Plan* by identifying new areas in which to extend the irrigation system, along with its operational requirements.

Consolidated Mutual Water Company is in the process of installing advance meters providing real-time data. This will greatly improve understanding of water use patterns, which today can only be ascertained from bimonthly bills. When the water meters are installed, they will be linked to the IC platform.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Divert heat from cooling towers to minimize the impact of the HPCDC
- Improve programming controls for use of the WeatherTRAK system
- Mitigate water consumption increases from the S&TF clean room through the recapture of reverse osmosis backwash water for cooling tower makeup water
- Replace air handlers in FTLB with high-efficiency units.

Fleet Management

Goals and Achievements

(5.1) 30% reduction in fleet-wide per mile greenhouse gas emissions by FY 2025 from a FY 2014 baseline (FY 2016 target: 3%)

- Fleet-wide per mile greenhouse gas emissions were 657 gCO₂e/mile, a 56% increase from the baseline year

(5.2) 20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter (FY 2016 target: 20%)

- Petroleum consumption increased 1% from the baseline to 7,810 GGE

(5.3) 10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter (FY 2016 target: 10%)

- Alternative fuel use increased 25% from FY 2015 to 21,207 GGE

(5.4) 75% of light duty vehicle acquisitions must consist of AFV's (FY 2016 target: 75%)

- No light duty vehicles were acquired

(5.5) 50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025 (FY 2016 target: 4%)

- No passenger vehicles were acquired. NREL does not currently have or plan to procure any vehicles classified as passenger vehicles.



NREL's fleet of alternative fuel vehicles operate on 100% alternative fuel. This vehicle uses E-85.

Fleet Management

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL is consistently meeting DOE's annual light-duty AFV acquisition goal and currently meeting the alternative-fuel-consumption increase goal. However, NREL continues to struggle in meeting the annual reduction goal in petroleum consumption and the green house gas per mile reduction.

The laboratory continues to look for additional options to reduce GHG impacts, promote alternative fuel use and AFVs, and establish new policies and programs. The NREL *Fleet Management Plan* (see Appendix B) discusses fleet management operating practices in further detail.

Petroleum Consumption Reduction

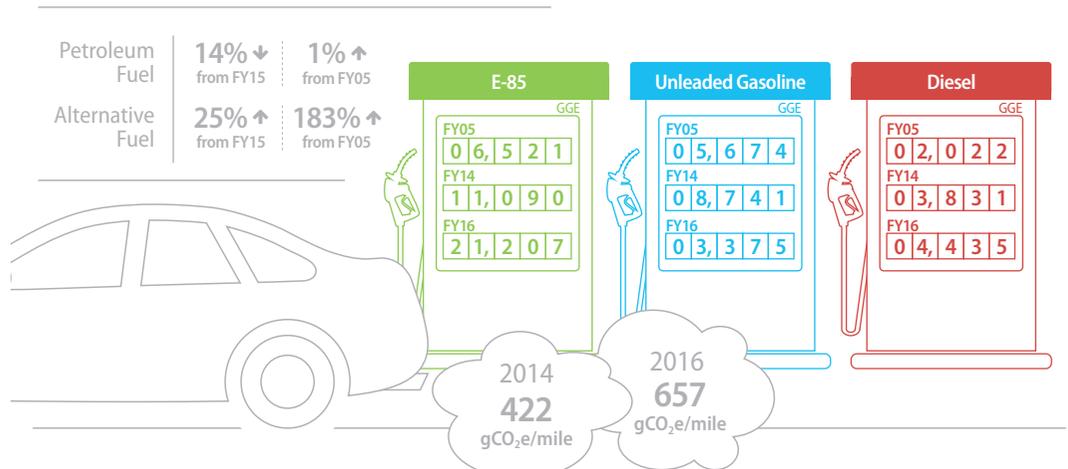
In FY 2016, NREL's petroleum consumption was 1% higher than the FY 2005 baseline and 14% lower than in FY 2015. Total consumption was 7,810 GGE (4,435 GGE of diesel and 3,375 GGE of unleaded gasoline). Despite the acquisition of a large fleet of AFV vehicles since the baseline year, diesel fuel vehicles including buses have yet to be replaced. The continued use of diesel vehicles in the fleet make meeting this goal difficult.

NREL continues to work on overcoming the challenges of reducing petroleum consumption on both campuses through methods such as fleet reduction, alternative fuel consumption, alternative transportation, and a no-idling policy. Referred to as the "30 Second Rule," NREL's no-idling guidance instructs fleet vehicle drivers to turn off their vehicle engines when parked

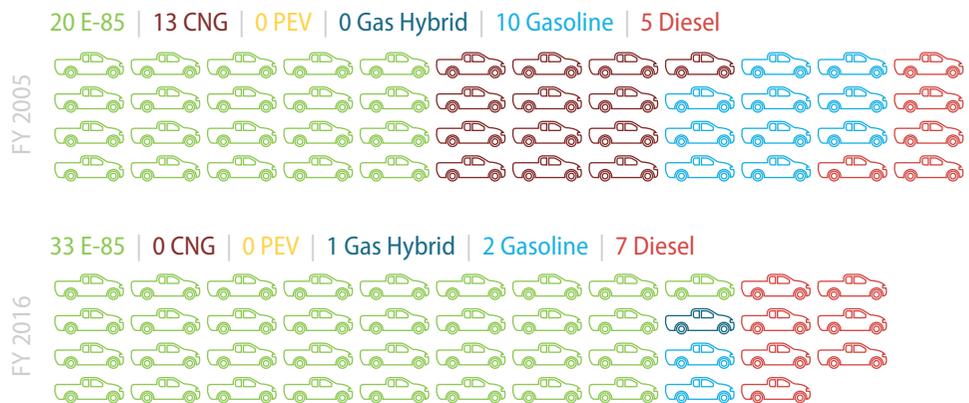
for more than 30 seconds. Exceptions apply for operating a vehicle in extremely cold or warm weather and for special circumstances such as emergency vehicles, vehicles engaged in traffic

operations or waiting at a traffic signal, and when a vehicle is being serviced. No-idling training and educational materials are available to all fleet operators through NREL's Intranet. No-idling signs

Fleet Performance: FY 2016



Fleet Vehicles



are posted at key locations near loading docks and passenger pick-up/drop-off locations.

NREL's fleet manager regularly monitors miles traveled, utilization rates (trips), and fuel consumption for all fleet vehicles. Monthly monitoring and reporting allows NREL to assess fleet performance and identify opportunities for improvement.

Alternative Fuel Consumption

Alternative fuel consumption increased by 25% from the FY 2015. This year the NREL fleet used 21,207 GGE of E-85. This increase is due to the relatively large number of E-85 vehicles in the fleet, the majority of which replaced unleaded-gasoline or unleaded-hybrid vehicles.

NREL has 36 electric vehicle charging stations on the STM campus that support research and fleet electric and plug-in hybrid electric vehicles. NREL employees and visitors are permitted to use the charging stations through a mission-critical research project—Expanding NREL's Energy Systems Integration Capabilities: Plug-in Electric Vehicle Load Control and Management—that is being conducted at the STM campus. NREL does not currently have any electric or plug-in hybrid electric vehicles in the fleet. The charging stations will support electric and plug-in hybrid electric vehicles added to the fleet in the future.

Greenhouse Gas Emissions Reduction

NREL's fleet-wide per-mile GHG emissions baseline for FY 2014 was 422 gCO₂e/mile. NREL tracks fuel usage and miles driven by vehicles and calculates its baseline based on this information. In FY 2016, the fleet-wide per-mile

GHG emissions increased to 657 gCO₂e/mile, a 56% increase from the FY 2014 baseline year. This increase can be attributed to the increase in petroleum fuel use in FY 2016 as well as the decrease in vehicle miles traveled in FY 2016 due to a double counting of law enforcement vehicle miles in FAST. In FY 2014, NREL emitted 123 MTCO₂e and drove 291,700 miles; in FY 2016, NREL emitted a total of 91.5 MTCO₂e from fleet fuel consumption and drove only 139,200 miles.

Alternative Fuel and Zero Emission Vehicle Purchases

NREL makes every effort to right-size its vehicle fleet, which currently consists of 43 vehicles—40 GSA-leased vehicles and three DOE-owned vehicles. In FY 2016, NREL completed a vehicle reduction analysis and determined that one vehicle should be removed from the fleet.

NREL had no vehicle acquisitions in FY 2016. The lab searched for zero emissions vehicles to add to the fleet but found none available through GSA that met NREL's vehicle classification needs.

The NREL fleet now consists of 77% AFVs:

- 33 E-85 vehicles
- 1 hybrid-gasoline vehicle
- 2 unleaded gasoline vehicles
- 7 diesel vehicles.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL continues to look for opportunities to make its campuses electric vehicle (EV)-ready. Specifically, NREL is exploring the opportunity to install charging capabilities at the NWTC so

that future fleet vehicle acquisitions could be EVs. Additionally, NREL continues to look for opportunities to replace its diesel shuttles, up for potential replacement in FY 2018, with alternative fuel or EV vehicles. NREL is presently considering a vendor, Zenith Motors, to provide an EV shuttle bus and is developing a path forward to procure the vehicle for use in NREL's fleet.

Using telematics in fleet management has proven to be an effective way of accurately managing fleet performance. In accordance with EO 13693, NREL plans to investigate and install telematics on all fleet vehicles in FY 2017. This data will be valuable in increasing productivity, controlling fuel, reducing operating expenses, and conducting a fleet reduction analysis to ensure that NREL has a right-sized fleet.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Explore the possibility of replacing diesel campus shuttles with an EV bus
- Reduce NREL's fleet by one vehicle based on the fleet reduction analysis
- Install fleet telematics in accordance with EO 13693
- Continue to increase AFVs and explore adding zero emission vehicles to the fleet in an effort to decrease fleet-wide per-mile GHG emissions.

Sustainable Acquisition

Goals and Achievements

(6.1) Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts

- 100% of construction contracts meet sustainable acquisitions requirements
- 100% of custodial contracts meet sustainable acquisitions requirements.

The radio frequency identification device pictured streamlines data collection by remotely detecting inventory data without physically scanning each item, reducing inventory errors. This technology allows NREL's chemical management system to more easily and efficiently track chemicals from the point of receipt through end-use and disposal improving research efficiency and minimizing hazardous waste generation.



Sustainable Acquisition

FISCAL YEAR 2015 PERFORMANCE STATUS

NREL is committed to environmentally preferable and sustainable purchasing that promotes the natural environment and protects the health and well-being of its employees, subcontractors, and visitors.

One hundred percent of NREL's FY 2016 construction and custodial contracts include BioPreferred (a United States Department of Agriculture designation) and bio-based provisions and clauses, meeting the requirements of DOE's Sustainable Acquisitions goal of 95% in FY 2016 (100% by FY 2020).

Products and Services

In FY 2016, NREL received a GreenBuy Award from DOE for its sustainable acquisition purchases in FY 2015. This marks the fifth consecutive year that NREL has been a GreenBuy Program Gold winner. NREL's purchase card (PCard) program and purchase request procedures have contributed to environmentally preferable and sustainable purchasing. Through the PCard program, employees are trained and given the tools to make informed choices on sustainable acquisitions for all laboratory purchases. Environmentally Preferable Products (EPPs) are defined for cardholders as products manufactured from recovered materials, energy-efficient products, bio-based products,

alternative fuels and fuel efficient vehicles, and non-ozone-depleting substances. PCard holders use this definition to identify their product purchases as "green" or "not green." Green purchases totaled 15% of NREL PCard purchases in FY 2016.

NREL uses the online system of EON, an authorized distributor with the Federal Strategic Sourcing Initiative, as the primary procurement tool to encourage the purchase of sustainable products. EON distributes a "green catalog" to NREL employees, who may choose from more than 4,000 earth-friendly office supply products in the catalog. In FY 2016, 51% of the items purchased through EON were EPPs.

Construction

Subcontractor contracts and statements of work include language to promote the purchase of products with the following characteristics:

- Energy efficient (ENERGY STAR- or FEMP-designated products)
- Water efficient (WaterSense)
- Bio-based
- Environmentally preferable (including those chosen via EPEAT)
- Non-ozone-depleting
- Recycled content
- Nontoxic or less toxic.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL will continue to implement new policies and programs and conduct training sessions to increase employee awareness of and accessibility to sustainable products. In addition, NREL will work with PCard administrators to provide resources to make it easier for purchasers to find information about green products and services and engage in contracts with providers of goods and services that are consistent with EO 13693.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Conduct PCard training classes with Q&A sessions
- Refine green purchase definitions with PCards
- Continue to require EPPs in contractor and custodial contracts.

Pollution Prevention and Waste Reduction

Goals and Achievements

(7.1) Divert at least 50% of nonhazardous solid waste, excluding construction and demolition debris

- Diverted 72% of non-hazardous solid waste from the landfill

(7.2) Divert at least 50% of construction and demolition materials and debris

- Diverted 88% of construction and demolition materials and debris from the landfill.



The Near-Zero Waste committee accepted the 2016 U.S. Department of Energy (DOE) Sustainability Award for NREL's waste diversion program. NREL was recognized for helping to ensure DOE remains a government-wide leader in sustainability.

Pollution Prevention and Waste Reduction

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL has initiated several campus-wide programs at the STM and the NWTC to meet DOE's performance targets for pollution prevention and waste reduction. NREL's 4R Philosophy—reduce, reuse, recycle, and re-buy—is guiding significant progress toward a near-zero-waste laboratory and reducing the need for new chemical purchases. At the same time, employee education, outreach, and information sharing is resulting in an “all-hands” effort to reduce waste, materials, emissions, and water and energy use.

In FY 2016, NREL diverted 71% of its nonhazardous solid waste, which is well above the performance target of 50%. Eighty-eight percent of construction waste, including demolition materials and debris, was diverted from small-scale campus projects. This is an increase from 75% in FY 2015.

NREL continues to meet solid waste and construction waste diversion goals, even with the added challenge of increased population and campus growth.

Waste Diversion

NREL focused on an information campaign in the first quarter of FY 2016, sharing tips and facts about waste diversion with employees. These resources were received positively by the NREL community.

In FY 2016, NREL subcontractors that provide composting services collected actual weights of compostable material. In the past, NREL has relied on estimates from haulers to determine composting diversion weights. This improvement in data collection will help NREL address diversion more intentionally and accurately in the future.

NREL's Occupational Health Clinic swapped out its disposable paper exam gowns in FY 2016, replacing them with reusable cloth gowns. The

new gowns save forest resources and reduce waste to the landfill while providing a more comfortable experience for users.

Construction and Demolition Waste Diversion

NREL's statement of work requires all subcontractors to track their waste and how it was diverted from the landfill. Subcontractors are given a Waste Tracking Log, similar to what is used in LEED projects in the Material Resources credit category. Project managers collect the logs at year's end to determine the percentage of materials that were recycled.

Pollution Prevention

In FY 2016, NREL conducted cleanout efforts in 29 laboratory spaces to maximize chemical storage space while properly managing unneeded reagents and research samples. All NREL employees attend a mandatory orientation for new employees that includes training on office-related chemicals and waste management. In addition, those employees who work in

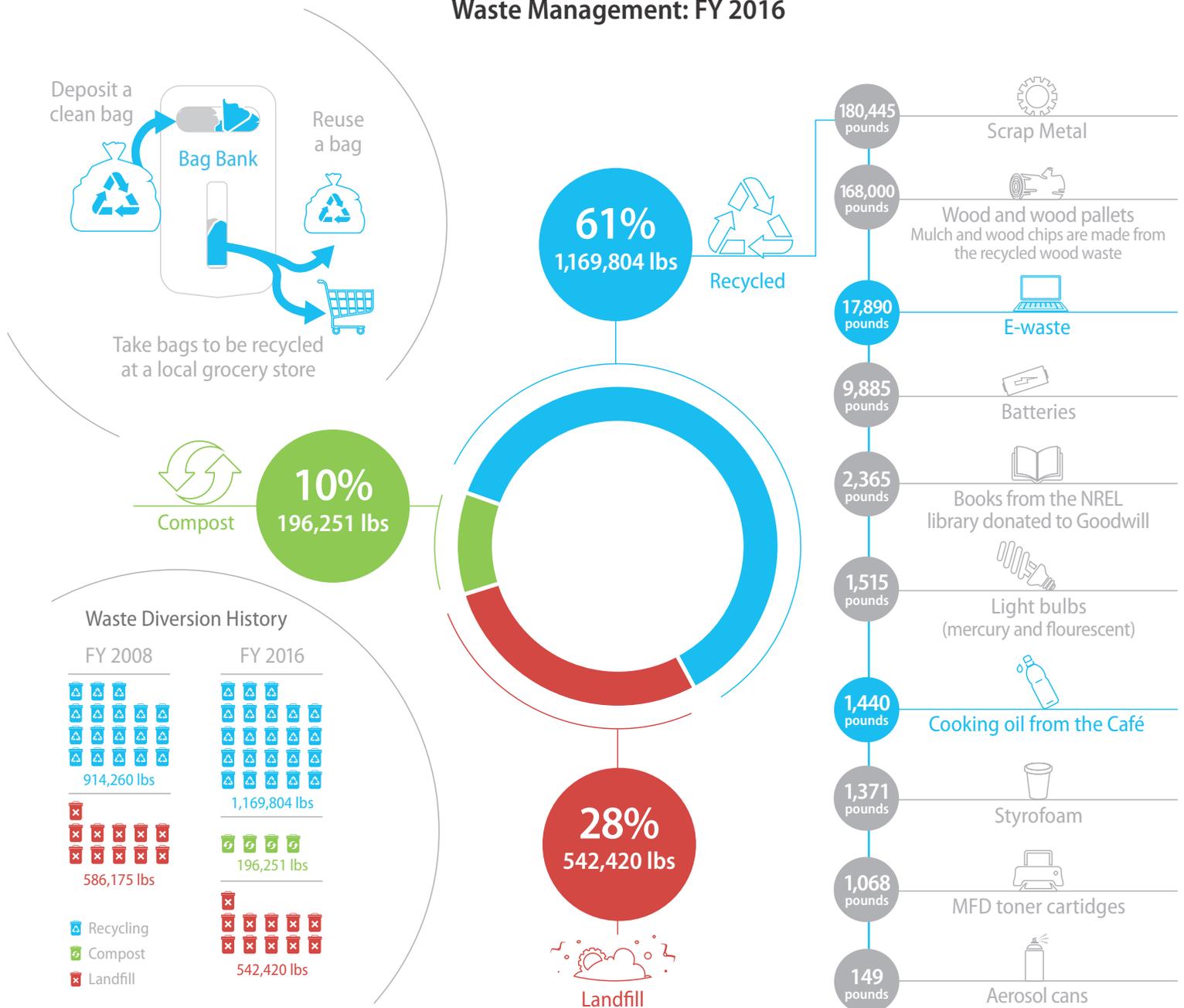
Success Story

NITRILE GLOVE RECYCLING

NREL piloted a nitrile glove recycling program at the Integrated Biorefinery Research Facility in FY 2016, collaborating with Kimberly Clark Professional's RightCycle (KC RightCycle) program. The KC RightCycle program is the first large-scale recycling program for non-hazardous cleanroom and laboratory waste. During the audit, nitrile gloves were collected after use in a specified bin. Full bins were shipped back to the KC RightCycle program and recycled into items such as park benches, tables, and fencing. The pilot collected 39 pounds of nitrile gloves in FY 2016 and has been very successful. NREL plans to expand the nitrile glove recycling program to other laboratories in FY 2017.



Waste Management: FY 2016



laboratories participate in a mandatory training session on chemical safety and hazardous waste management and minimization. Workers use a formal hazard identification and control process, which serves as a tool to identify and substitute chemicals that may be less hazardous to workers and the environment. Trainings are reviewed and updated on a continuous basis, and any changes are communicated to affected staff through the required annual laboratory safety refresher training.

When pest wildlife species need to be controlled, NREL uses an integrated approach to humanely eradicate pests when necessary and minimize other potential impacts. In FY 2016, Environment, Health, and Safety (EHS) and SITE Operations collaborated on a project to retrofit the STM parking garage walkway with netting in order to eliminate pigeon nesting and roosting in the area. In addition, eleven species of noxious weeds were treated at both the NWTC and the STM campus: bull thistle, knapweed, Canada thistle, common teasel, musk thistle, dalmation toadflax, downy brome, moth mullein, myrtle spurge, Sulphur cinquefoil, and Russian olive. NREL had a huge success in reducing the density of knapweed at the NWTC to a few scattered individual plants and low-density patches.

Instead of herbicides, biocontrol agents were used in a test area at the NWTC against knapweed and Canada thistle. The Colorado Department of Agriculture provided NREL with knapweed-loving weevils as an integrated approach to noxious weed control. Rust (a fungus that attacks leaves) was used against Canada thistle. Biological pest control helps decrease reliance on chemical pest control.

NREL continued work to eliminate myrtle spurge from the STM site. Myrtle spurge plants were treated with herbicide twice during the year, and

any remaining sprigs were hand-pulled in the late summer of 2016. It is likely that roots of the myrtle spurge plants are still viable and growth may appear in 2017. Alternating hand-pulling and herbicide use reduces the use of herbicide but still stresses the myrtle spurge root systems. NREL continues to work toward its goal to eliminate myrtle spurge; however, it may take additional growing seasons to achieve it. In addition, Russian olive trees at the STM campus were girdled and treated with small amounts of herbicide in the girdled areas. Physical disturbance (girdling) used with herbicide increases the effectiveness of the herbicide and may decrease the need to reuse herbicide on Russian olive trees in the future.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

Employee participation is paramount in meeting DOE's pollution prevention and waste reduction goals. Staff plays an important role in helping reduce the amount of solid waste reaching landfills as recycled and compostable materials increase. Staff members also submit new ideas through the Sustainable NREL website and emails. In FY 2016, NREL will continue to provide training to existing and new employees to promote sustainable and resilient campuses.

In FY 2017, NREL is planning to develop a short video for NREL employees with an overview about the recycling and composting program.

Through previous waste audits, NREL determined that, although laboratories like the FTLB could make changes to facilitate a higher waste diversion rate, laboratory hazards make the process difficult. In FY 2017, NREL will work with EHS on a combined effort to develop a laboratory waste diversion plan for implementation in FY 2018.

In an effort to increase construction waste diversion rates in FY 2017, NREL will make a conscientious effort to work closely with project managers and enforce subcontractor statement of work requirements for all construction projects, big or small.

NREL is committed to using alternative chemicals and processes and will continue to give preference to EPPs, including bio-based products, the Electronic Procurement Environmental Assessment Tool (EPEAT), and low- or no-volatile-organic-compound paints. NREL will also continue to use a chemical management system to track chemical purchases, management, and disposal. Further, the laboratory will continue to maintain an "excess chemical inventory" that allows users to exchange chemicals within NREL when unneeded chemicals are available, reducing the need for acquiring new materials as well as the need to dispose of chemicals as regulated waste.

MEASURABLE GOALS

In FY 2017, NREL will:

- Develop a plan to achieve higher diversion rates and reduce overall waste in the laboratories
- Work with project managers to collect data each month about construction projects to increase diversion rates
- Continue to manage hazardous waste streams in a safe and compliant manner while seeking opportunities to promote sustainability and waste minimization
- Treat myrtle spurge at the STM campus
- Control noxious weeds on 100 acres at NWTC and 15 acres at STM, specifically targeting knapweed and Canada thistle.

Energy Performance Contracts

Goals and Achievements

(8.1) Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693

- NREL will explore using ESPCs, along with other alternative financing mechanisms, but will only pursue economically feasible options. In addition, NREL will continue to utilize other funding options such as REC sales, utility rebates, and in-house savings reinvestment funds.

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL's sustainable campus design serves as a replicable model of state-of-the-art energy efficiency and renewable energy technologies and practices. Realizing the value of energy performance contracting to support the installation of progressive technologies on campus, NREL pursues PPAs, energy savings performance contracts (ESPCs), and utility energy services contracts to the greatest extent possible.

To date, NREL has completed one ESPC project for the RFHP on the STM campus and eight PPAs throughout both the STM and NWTC sites that have led to the installation of 9 MBtu per hour of thermal resource, 2.35 MW of solar PV, and 8.18 MW of wind.

As opportunities arise to explore new ECMs, the deployment of additional onsite renewables, and the construction of new high performance and sustainable buildings, NREL will investigate appropriate mechanisms to finance these projects. NREL did not find any projects in FY 2016 to be fiscally responsible options.

Approach and Challenges

In FY 2016, NREL submitted a proposal to receive funding under a SPOFOA—and was awarded the funding—to reduce the price per kWh of a PPA for multiple new solar PV arrays with the collective capacity ranging between 1.2 and 1.6 MW. However, due to future mission real estate needs, NREL and DOE GO executive management determined the project could move forward only as a rooftop system. NREL did not have the rooftop space required to make the project financially feasible and so it was canceled.

NREL has a substantial list of unfunded opportunities for energy and water reduction that could be bundled into an ESPC. The laboratory has determined, however, that bundling current unfunded ECMs is not necessarily viable economically; therefore, the cost savings from bundling ECMs may not support an ESPC.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

In FY 2017 and beyond, NREL will explore using ESPCs, along with other alternative financing mechanisms, but will only pursue economically feasible options. In addition, NREL will continue to utilize other funding options such as REC sales, utility rebates, and in-house savings reinvestment funds.

Electronic Stewardship

Goals and Achievements

(9.1) Purchases – 95% of eligible acquisitions each year are EPEAT-registered products

- 99% of eligible electronic acquisitions met EPEAT standards

(9.2) Power management – 100% of eligible PCs, laptops, and monitors have power management enabled

- Power management is enabled on 100% of eligible PCs and laptops

(9.3) Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled

- 100% of MFDs have automatic duplexing enabled
- 100% of eligible personal printers have automatic duplexing enabled

(9.4) End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year

- 100% of electronics at their end of life were donated, resold, or recycled using environmentally sound disposition practices. 17,890 pounds of electronics were recycled

(9.5) Data Center Efficiency – Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers

- The RSF data center had an average PUE of 1.16
- The HPC data center had an average PUE of 1.04.



NREL's electronics purchasing team was awarded the 3 Star 2016 EPEAT Purchaser Award for their exceptional commitment in support of NREL's mission to ensure purchases meet established EPEAT and Energy Star ratings wherever possible.

Electronic Stewardship

FISCAL YEAR 2016 PERFORMANCE STATUS

NREL promotes electronic stewardship through life-cycle management of electronics from procurement to disposal. By using sustainable acquisitions, power monitoring, efficiency measures, and responsible disposal, NREL continues to improve performance in DOE's electronic stewardship goal year after year.

Purchases

NREL has long-established standards for computing equipment, which take into account sustainable acquisitions and operations best practices, business needs, and responsible disposal. NREL also directs purchases for eligible equipment through vendors who have knowledge of EPEAT, a source of environmental product ratings, and can offer equipment that meets and exceeds EPEAT's stringent standards. By establishing this standard and review process, NREL is able to direct the vast majority of its computing equipment purchasing toward EPEAT-compliant models and options.

In FY 2016, 100% of eligible computers and monitors and 99% of total eligible electronics purchases (including computers, monitors, tablets, imaging equipment, and televisions) met the EPEAT standards. Furthermore, 97% of eligible equipment purchases were ENERGY STAR-certified. Also in FY 2016, the Green Electronics Council awarded NREL with a Three-Star EPEAT Purchaser Award, recognizing NREL's excellence in the green procurement of electronics.

NREL continues to improve and monitor its electronic stewardship practices throughout the entire life-cycle of its IT equipment and infrastructure—acquisition and procurement, operations and maintenance, and end-of-life management.

Power Management

Power management settings are enabled on all eligible personal computers (PCs), laptops, and monitors before being deployed to employees or installed on any NREL site. Devices are set to turn off the display after 10 min of inactivity and put the hard drive into standby mode after 15 minutes of inactivity. In addition, all electronic

devices in the RSF are plugged into power management surge protectors that cut off power to inactive devices when not in use. NREL also continuously monitors the power usage of plug loads at the workstation level in the ESIF.

Automatic Duplexing

EPEAT and ENERGY STAR-certified multifunction devices (MFDs) continue to replace existing printers, copiers, scanners, and fax machines, effectively reducing the need for standalone imaging equipment. Three EPEAT Gold MFDs were purchased this year. Currently, 73 MFDs throughout the STM and NWTC campuses and the Washington, D.C., office default to double-sided, black and white copies, which saves paper and toner ink. All new facilities are required to use MFDs.

Electronics: End of Life

NREL has a laboratory-wide sustainability practice that addresses recycling, reuse, composting, transportation, plug loads, and staff behaviors, among other programs. Electronics end-of-life management is no exception. All cartridges from MFDs are sent back to the

Success Story

THREE-STAR EPEAT PURCHASER AWARD

In FY 2016, NREL received the Three-Star EPEAT Purchaser Award from the Green Electronics Council for 2015 EPEAT purchases. Over the lifetime of those products purchased in 2015, NREL will reduce the use of primary materials by 54.9 metric tons, avoid the disposal of 474 kg of hazardous waste, and eliminate the equivalent of one U.S. household's solid waste—378 kg—for 2 months. In addition, the purchase of those products will save an estimated 149,630 kWh of electricity, avoid 192 kg of water pollutant emissions, and reduce GHG emission by 27.9 metric tons. NREL is committed to the purchase of products designated by EPEAT, ENERGY STAR, and FEMP, where feasible, to continue to positively impact the environment through these purchases.

manufacturer or a subcontractor for recycling. One hundred percent of electronics at the end of their useful lives in FY 2016 were recycled in an environmentally sound way, donated, or resold. NREL's electronics recycler holds a number of certifications including: e-Stewards®, Responsible Recycling (R2), ISO 9001, ISO 14001, and OHSAS 18001. In FY 2016, NREL recycled 17,354 pounds of electronic waste and 536 pounds of computer monitors, auctioned off 463 electronics items, and donated another 32 electronics items.

Data Center Efficiency

The primary core data center supports staff business operations for NREL's campuses and is located in the RSF—a LEED Platinum building designed as net zero facility. The RSF data center's power usage effectiveness (PUE) is managed by metering the following loads: lighting, uninterrupted power supply, power distribution units, air-handling units, and chilled water. The data center's meters are connected to the RSF energy monitor for real-time visualization of data center performance. Cloud services are under investigation as a method of further reducing onsite computing needs; however, the services must be Federal Risk and Authorization Management Program (FedRAMP)-certified before they can be used.

In FY 2016, NREL met DOE's goal of at least a 1.40 PUE as well as NREL's internal goal of obtaining a PUE less than 1.20. The average PUE for the RSF data center has been exceeding this threshold since it began operating in 2010, more than four years before EO 13693 was released. In FY 2016 the RSF PUE was 1.16, lower than the 1.19 PUE that NREL achieved in FY 2015. The average PUE for the HPCDC was 1.04, which was also lower than the FY 2015 performance of 1.06.

The state-of-the-art HPCDC in the ESIF is a national resource for scientific computing. Its powerful processing capabilities, efficient design, and innovative waste heat capture for reuse make it the most energy-efficient data center in the world.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

NREL's goal is to enable power management settings on 100% of eligible computers throughout the useful life of the equipment. For power management strategies to be successful, however, staff participation is essential. In FY 2017, NREL will continue to focus on educating staff about the importance of using power management settings through focused training sessions and competitions.

The IT asset management team will continue to work closely with the office of the chief information officer (OCIO) to increase the percentage of purchases filtered through NREL's basic ordering agreements purchasing contracts. Through this collaboration, OCIO will be able to monitor and recommend products based on EPEAT and ENERGY STAR guidelines, thereby continuing to increase NREL's commitment to electronic stewardship.

The HPCDC will continue to experiment with a thermosyphon technology in FY 2017 to cool the data center with significant reductions in water consumption. Researchers estimate water use could be reduced by as much as half with this new technology.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Continue to uphold best practices for electronic stewardship
- Educate staff on the importance of using power management settings
- Continue to pursue an average PUE below 1.2 in the RSF Data Center
- Continue to pursue an average PUE below 1.06 in the HPCDC.

Climate Change Resilience

Goals and Achievements

(10.1) **Update policies to incentivize planning for, and addressing the impacts of, climate change**

(10.2) **Update emergency response procedures and protocols to account for projected climate change, including extreme weather events**

(10.3) **Ensure workforce protocols and policies reflect projected human health and safety impacts of climate change**

(10.4) **Ensure site/lab management demonstrates commitment to adaptation efforts through internal communications and policies**

- NREL's recent vulnerability assessment and resiliency action plan identified all these goals as resilience options and will pursue these changes in FY 2017 and in the future
- (10.5) **Ensure that site/lab climate adaptation and resilience policies and programs reflect best available current climate change science, updated as necessary**
- NREL's recent vulnerability assessment and resiliency action plan utilized current climate science information provided by the Western Water Assessment, our region's Regional Integrated Science and Assessment climate science research team.

Resilience planning in the face of a changing climate is a top priority for NREL. Beginning with the Resilience Action Plan, NREL continues to explore opportunities to incorporate climate change resilience throughout the laboratory.



Climate Change Resilience

FISCAL YEAR 2016 PERFORMANCE STATUS

The NREL campuses are living laboratories that demonstrate long-term, whole-community solutions for a sustainable, energy-resilient infrastructure. As climate change becomes more prevalent worldwide, NREL is proactively engaged in mitigation and adaptation strategies both inside its laboratories and externally on both campuses. One example is the ESIF, for which grid resilience and the state of the electric grid system are being studied, along with the grid's ability to meet clean energy needs in a changing climate.

Planning for Climate Change: Regional and Local Coordination

NREL anticipates the completion of the White House Council on Environmental Quality's Climate Change Preparedness Pilot in cooperation with the State of Colorado in late October 2016. The intention of the pilot is to bring federal agencies and local communities together to assess and plan for region-specific

vulnerabilities and interdependencies associated with climate change impacts. The goal of the pilot is to create a model for other communities and agencies to follow. Findings from the pilot will be reported back to the White House Council on Environmental Quality in FY 2017.

NREL continued support to the Colorado Resiliency Working Group by providing technical assistance and leadership as a federal liaison. In FY2016, NREL contributed to the development of the Colorado Resiliency Framework that provides guidance for Colorado communities as they work to build resiliency to climate change and other challenges. NREL also contributed to the development of two interagency coordination projects. One project facilitated cooperation and coordination among state agencies and federal partners on resiliency actions for local infrastructure projects. The second developed a state resource database containing best management practices, redefining criteria standards and locations of physical assets.

Planning for Climate Change: The NREL Campuses

Preparing for the impacts of future climate change requires planning now for dynamic occurrences. NREL increased its internal capacity specifically to address climate change planning on the campuses. In FY 2016, NREL published its vulnerability assessment and resilience action plan, which are available to the public on NREL.gov. During FY 2016, NREL began to investigate several strategies identified in the resilience action plan. Three of the major activities follow:

- Developing requirements for control technologies and processes to better manage electricity demand
- Conducting preliminary analysis of adding battery storage on the STM campus to investigate the feasibility of "islanding" facilities during power outages
- Designing and constructing slope stabilization for eroding hillsides of the STM campus due to high peak storm events.

Success Story

DOE CLIMATE CHANGE ADAPTATION AWARD

In FY 2016, NREL was recognized with a DOE Climate Change Adaptation Sustainability award for NREL's work in resilience planning in the face of a changing climate. DOE's Sustainability Performance Office funded NREL to develop a process for climate change resilience planning that could be leveraged at other DOE sites. In addition to the vulnerability assessment and resilience action plan published in FY 2016, NREL also published a summary and best practices document to communicate the process used in the vulnerability assessment. NREL has utilized this document when at presentations and when meeting with other DOE sites as they explore how to conduct a vulnerability assessment. The replicable assessment process developed at NREL will help support other DOE sites as they undertake planning efforts to manage near- and longer-term climate risks.

In FY 2016, with funding support from the DOE Sustainability Performance Office, NREL began assisting DOE's Strategic Petroleum Reserve and Los Alamos National Laboratory with their own climate change vulnerability assessments as pilot projects. Both projects are anticipated to be completed in FY 2017.

Emergency Response Procedures

The emergency response procedure has not yet been updated to account for projected climate changes. One of the resilience options identified is to update existing plans and procedures to include climate change considerations. These include the emergency preparedness plans, which will be a part of the program implementation plan development in FY 2017.

Workforce Protocols

Workforce protocols have also not yet been updated to reflect human health and safety from the impacts of climate change, but are one of the resilience options identified. This will be a part of the program implementation plan development in FY 2017.

Internal Communications

NREL strives to maintain a high level of awareness in the laboratory around safety, health, and environmental responsibilities. In FY 2016, NREL installed a long-range acoustic device on the STM campus. The system allows NREL's Office of Security and Emergency Preparedness to communicate vital information to employees who are outdoors on the STM campus in the event of a tornado warning, weather or wildlife warning, or an active security threat. As management approves resilience options and planning gets underway in FY 2017, internal communications will be a vital component of the implementation strategy.

Policy and Program Updates

Resilience planning is a risk-management strategy. NREL plans to continue to assess climate change vulnerabilities regularly. The goal of the participatory stakeholder-driven approach is to grow internal capabilities and decentralize climate change adaptation and resilience planning into everyday business practices.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

In FY 2017, NREL plans to develop a program implementation plan around climate change resilience. As part of the program implementation plan, NREL and DOE GO executive management will be made aware of potential climate change resilience planning strategies. Plans and policies will be updated as necessary to reflect strategies identified. In addition, NREL hopes to continue progress on initiatives that began in FY 2016.

NREL recognizes that climate change impacts and successful adaptation strategies that build resilience extend beyond the laboratory's organizational control and geographic boundaries. As a result, coordination with surrounding communities is critical. NREL plans to engage external stakeholders in a regional symposium when the vulnerability assessment and resilience action plan development efforts conclude. The intent is to share what has been learned through the process, discover what community partners are doing to plan for climate change, and identify opportunities for local partnerships and cooperation. The goal of the symposium is to initiate a long-term dialogue to improve the collective understanding of climate change science, share best practices and data, and establish regional coordination in adaptation planning and policy.

MEASUREABLE GOALS

In FY 2017, NREL will:

- Develop the program implementation plan for climate change resilience planning
- Update plans and policies where necessary to reflect the strategies of climate change resilience identified
- Brief the NREL and DOE GO executive leadership team on these efforts
- Make additional progress on some of the early action items that began in FY 2016.

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