



Site Sustainability Plan FY 2013

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.

NREL campus yesterday...



As market demand for renewable energy and energy efficiency continues to expand, NREL responds. To fulfill our mission NREL's employee population has increased 84% since FY 2003. During this robust growth trend our campus building footprint expanded from 436,941 ft² in FY 2003 to 922,337 ft² in FY 2012—a 111% increase.

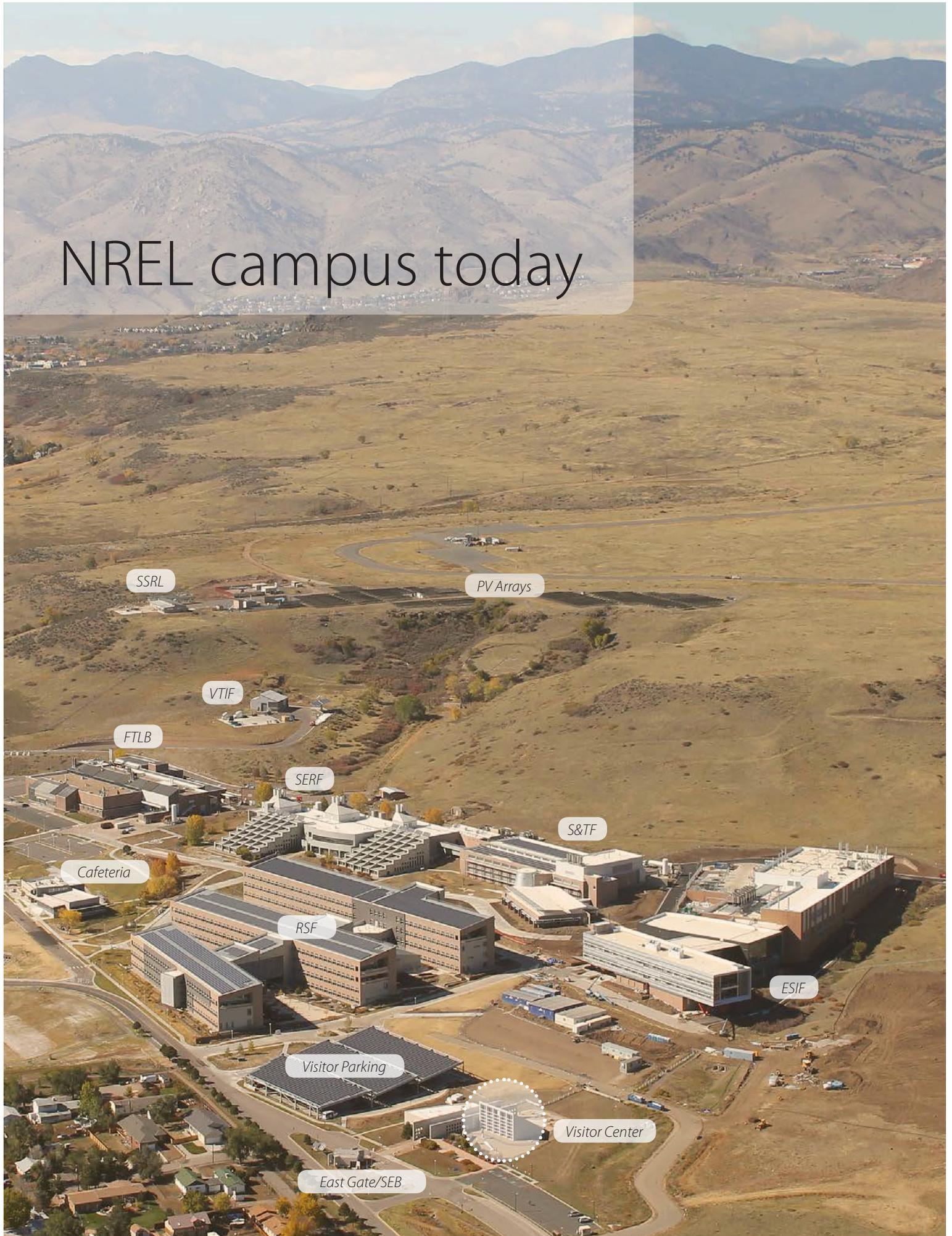
Site Sustainability Plan 2013

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NREL campus today



NOMENCLATURE

AFV – Alternative Fuel Vehicles	ISMS – Integrated Safety Management System
ARRA – American Recovery and Reinvestment Act	IT – Information Technology
ASHRAE – American Society of Heating, Refrigerating, and Air-Conditioning Engineers	kBTU – Thousand British Thermal Units
AWS – Alternative Work Schedules	kW – Kilowatt
BA – Building Agent	kWh – Kilowatt-hour
BAS – Building Automation System	LDRD – Laboratory Directed Research and Development
BTU – British Thermal Units	LEED – Leadership in Energy and Environmental Design
BBTU – Billion British Thermal Units	LEED EB-O&M – LEED Existing Buildings: Operations and Maintenance
CAIS – Condition Assessment Information System	LEPC – Local Emergency Planning Committee
CD – Construction Document	LID – Low Impact Development
CEDR – Consolidated Energy Data Report	LPD – Light Power Density
CEQ – Council on Environmental Quality	MMBTU – Million British Thermal Units
CLI – Construction Line Item	MFD – Multifunction Devices
CNG – Compressed Natural Gas	MTCO_{2e} – Metric Ton Carbon Dioxide Equivalent
CO₂ – Carbon Dioxide	MW – Megawatt
CRADA – Cooperative Research and Development Agreement	MWh – Megawatt-hour
CTI – Climate Technology Initiative	N₂O – Nitrous Oxide
DC Pro – Data Center Energy Profiler Software Tool Suite	NC – New Construction
DOE – Department of Energy	NEPA – National Environmental Policy Act
EA – Environmental Assessment	NWTC – National Wind Technology Center
E85 – Ethanol 85	NREL – National Renewable Energy Laboratory
ECM – Energy Conservation Measure	OECM – Office of Engineering and Construction Management
EERE – Office of Energy Efficiency and Renewable Energy	OMB – Office of Management and Budget
eGRID – Emissions and Generation Resource Integrated Database	OTF – Outdoor Test Facility
EHS – Environment, Health, and Safety	PCards – Purchase Cards
EISA – Energy Independence and Security Act of 2007	PDF – Portable Document Format
EO – Executive Order	PEV – Plug-In Electric Vehicle
EMS – Environmental Management System	PPA – Power Purchase Agreement
EPA – Environmental Protection Agency	PPI – Pollution Prevention Initiative
EPACT – Energy Policy Act of 2005	PPTRS – Pollution Prevention Tracking and Reporting System
EPEAT – Electronic Product Environmental Assessment Tool	PUE – Power Usage Effectiveness
EPP – Environmentally Preferable Products	PV – Photovoltaics
ESCO – Energy Services Company	R&D – Research and Development
ESIF – Energy Systems Integration Facility	RE – Renewable Energy
ESPC – Energy Savings Performance Contract	REC – Renewable Energy Certificate
FAA – Federal Aviation Administration	REDB – Research Electrical Distribution Bus
FAST – Federal Automotive Statistical Tool	RFHP – Renewable Fuel Heat Plant
FC – Foot candle	RSF – Research Support Facility
FEC – Federal Electronics Challenge	RTD – Regional Transportation District
FEMP – Federal Energy Management Program	SEAC – Strategic Energy Analysis Center
FIMS – Facilities Information Management System	SEB – Site Entrance Building
FTLB – Field Test Laboratory Building	SSEB – Southern Site Entrance Building
FY – Fiscal Year	SERF – Solar Energy Research Facility
ft² – Square Feet	SF₆ – Sulfur Hexafluoride
GHG – Greenhouse Gas	SOW – Statement of Work
GGE – Gallons of Gas Equivalent	SRRL – Solar Radiation Research Laboratory
GSA – General Services Administration	SSP – Site Sustainability Plan
GSF – Gross Square Feet	SSPP – Strategic Sustainability Performance Plan
GP – Guiding Principles	S&TF – Science and Technology Facility
GWP – Global Warming Potential	STM – South Table Mountain
HPCDC – High Performance Computing Data Center	Sustainable NREL – NREL's Sustainability Program
HPSB – High Performance Sustainable Buildings	T&D – Transmission and Distribution
HVAC – Heating Ventilation Air Conditioning	TEAM – Transformational Energy Action Management
IBRF – Integrated Biorefinery Research Facility	UDFCD – Urban Drainage and Flood Control District
IES – Integrated Environmental Strategies	UNFCCC – United Nations Framework Convention on Climate Change
ILA – Industrial, Landscaping, and Agricultural	USGBC – United States Green Building Council
IPCC – Intergovernmental Panel on Climate Change	VOC – Volatile Organic Compounds
IPT – Integrated Project Team	ZEB – Net-Zero Energy Building

EXECUTIVE SUMMARY

The Open EI team at NREL's Research Support Facility. Open EI is a website that uses a crowd sourcing platform to provide energy information to consumers and utilities.

SITE MANAGEMENT VISION

The Department of Energy's (DOE) National Renewable Energy Laboratory's (NREL) goal is to expand our leadership as a state-of-the-art laboratory that supports innovative research, development, and commercialization of renewable energy and energy efficiency technologies that address the nation's energy and environmental needs. Fundamental to this goal is NREL's commitment to sustainability—operating in a manner that balances environmental, economic, and social values in the delivery of our mission. At NREL, sustainability is integral to both our research and operations. NREL is committed to demonstrating federal leadership in sustainability, working to continuously improve our performance, and lead by example.

NREL'S SUSTAINABILITY PROGRAM

Sustainable NREL is a long-standing laboratory program that fosters environmental and social responsibility, working to establish the lab as a global model for sustainability. Sustainable NREL advocates for all executive orders, federal regulations, DOE orders, and goals related to sustainable facility operations. This program also executes NREL-specific goals to reduce our impacts on the community and environment and provides technical expertise to other organizations within the lab. Sustainable NREL provides leadership within the federal government and our community by actively mentoring and collaborating with other organizations to move sustainability into a new paradigm.

NREL's campus is a living laboratory that showcases new technologies, design practices, and operating behaviors. In all campus development, NREL looks for opportunities to integrate energy efficiency and renewable energy, high-performance buildings, and sustainable transportation options. On-site deployment of technologies developed by NREL researchers is also emphasized.

MAJOR PLANNING ASSUMPTIONS, ISSUES, FUNDING STRATEGIES

In previous years, NREL has experienced a robust growth trend. In FY 2003, our population was 1,132 and our building square footage was 405,367. In FY 2012, our population was 2,447 and our building square footage was 946,625, as reported in the Consolidated Energy Data Report (CEDR). The percentage increase was 116% for population and 134% for building square footage.

While currently experiencing growth, in the current economic climate NREL is uncertain that this trend will continue. While there are no new Construction Line Item (CLI) funding identified at this time, NREL is conducting planning activities so that we are positioned to accommodate future growth through the construction of new high-performance buildings, energy efficiency retrofits, and renewable energy systems that take advantage of alternative financing mechanisms, including power purchase agreements (PPA), energy savings performance contracts (ESPC), partnerships with energy service companies (ESCO), and cooperative research agreements (CRADA). NREL continues to review the use of overhead funds, cost savings reinvestment, and leveraging of alternative finance for retrofits or new projects.

SUCCESSES AND CHALLENGES

In FY 2013, construction of the Energy System Integration Facility (ESIF) will be complete and the design for the expansion of the existing Outdoor Test Facility (OTF) will begin. Even with all new construction meeting Leadership in Energy and Environmental Design (LEED) Gold or higher, certification standards and the addition of new on-site renewable systems, NREL's demand for energy and water will increase. Subsequently, greenhouse gas (GHG) emissions from purchased energy and travel will continue to grow even though impacts are being reduced on a per capita basis. Scope 3 GHG emissions will continue to be a high priority for NREL in our development of innovative solutions.

To reduce energy consumption from recent staff growth and the transition of staff from offsite leased office space to the South Table Mountain (STM) campus, NREL constructed four new high-performance sustainable buildings and three on-site renewable systems in FY 2012.

- Achieved LEED Platinum certification from the U.S. Green Building Council for the new net-zero energy Research Support Facility II (RSF II)
- Completed the net-zero energy Parking Garage designed to LEED Platinum rating
- Completed the net-zero energy Southern Site Entrance Building (SSEB), LEED Platinum certification anticipated
- Completed the Cafeteria, LEED Gold certification anticipated
- Deployed new on-site renewable energy systems including:
 - 15.28 kW PV array on rooftop of SSEB
 - 408 kW PV array on rooftop of RSF II
 - 1130 kW PV array on rooftop and southern façade of Parking Garage.

In FY 2012, NREL was recognized for several prestigious awards that acknowledged our performance in sustainability:

- DOE Sustainability Award for Comprehensive Energy Management Plan. DOE Sustainability Awards highlight environmental impacts mitigation, enhanced site operations, reduced costs, and demonstrate excellence in pollution prevention and sustainable environmental stewardship.
- DOE Green Buy Program Gold Award, achieving the leadership goal for 17 products in five different categories
- EPA's Federal Electronics Challenge (FEC) Platinum Level Award, which recognizes electronic stewardship that helps the federal government improve its sustainable practices when purchasing, managing, and disposing of their electronic assets.

SUMMARY

The following table summarizes each of DOE's Strategic Sustainability Performance Plan (SSPP) goals along with NREL's performance status, planned actions, and an assessment of the risk of non-attainment as noted below:

- *Technical risks.* Technology is available or not available in current facilities and systems to attain the goal.
- *Management risks.* Management systems and/or policies may require changes for which approval authority is outside the sustainability program.
- *Financial risks.* Funds are/are not identified in current or out-year targets to achieve the goal.

Each risk is assigned a rating of high, medium, low.

- *High (H).* Risk in at least one of the three categories is so significant that non-attainment of goal is likely or expected.
- *Medium (M).* Risk in at least one of the above categories is so significant that it is moderately likely that the goal that will not be attained.
- *Low (L).* Any risks associated with this goal are being satisfactorily mitigated such that attainment of the goal is likely.

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Performance Status in FY 2012	Planned Actions and Contribution in FY 2013	Risk of Nonattainment High (H), Medium (M), Low (L)
1.1	28% Scope 1 & 2 GHG reduction by FY 2020 from a FY 2008 baseline.	NREL reduced Scope 1 and 2 emissions 84% from the 2008 baseline (including RECs).	Purchase RECs to offset all Scope 2 emissions.	L – NREL has committed to generate on-site power, purchase renewable power and RECs to offset emissions.
1.2	14% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline.	NREL Scope 3 GHG emissions increased 12% from the 2008 baseline.	<p>Explore feasibility of implementing improved data collection methods for more accurate assessment of ground travel impacts.</p> <p>Provide shuttle service to RTDs new West Corridor Light Rail Line.</p> <p>Explore feasibility of implementing on-site bike share program.</p>	M – Management Risk: To support NREL's mission air travel is necessary. While on a per capita basis NREL will meet the reduction goal, the absolute reduction from the 2008 baseline will be challenging due to population growth.
2.1	30% energy intensity reduction by FY 2015 from a FY 2003 baseline.	Energy intensity decreased 29% since 2003.	<p>Perform EISA audits of DOE-owned facilities.</p> <p>Populate the Portfolio Manager tool and pursue ENERGY STAR® certification for qualified buildings.</p>	L – NREL will meet this goal provided the ESIF data center can be excluded from the energy intensity calculation.
2.2	EISA Section 432 energy and water evaluations.	Performed energy and water audits on three buildings that represent 50% of total site energy use in FY 2012.	NREL will conduct ASHRAE level 2 audits on four covered facilities using in-house expertise. As new LEED buildings are constructed they will be commissioned, bringing these facilities into EISA compliance. Once the next four-year cycle of EISA audits is complete, NREL will have assessed over 80% of the site energy use.	L – NREL has conducted audits for buildings that represent 50% of the total site energy use. In the next three years NREL will conduct audits for 10 more buildings. By 2015, NREL will have assessed over 80% of the site energy use.
2.3	Individual buildings or processes metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015).	<p>100% of NREL's electricity, hot and chilled water is metered in FY 2012.</p> <p>95% of natural gas is metered in FY 2012.</p>	The NWTC metering upgrade plan focuses on NWTC metering infrastructure improvements including, installing and replacing new power quality meters with less susceptibility to setting loss/errors and improved communication using TCP/IP rather than Modbus, alarm reporting, and remote meter resetting and calibration.	L – In FY 2012, NREL is in full compliance.
2.4	Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.	59% of NREL campus has cool roofs, an 11% increase from FY 2011.	<p>TTF roof will be replaced with a cool roof in FY 2013.</p> <p>NREL will continue to evaluate economic feasibility of existing roof replacement with cool roofs.</p> <p>All new LEED certified buildings will receive cool roofs.</p>	L – NREL will continue to comply with this requirement.

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Performance Status in FY 2012	Planned Actions and Contribution in FY 2013	Risk of Nonattainment High (H), Medium (M), Low (L)
2.5	15% of existing buildings greater than 5,000 gross square feet (GSF) are compliant with the Guiding Principles (GPs) of HPSB by FY 2015.	NREL is currently 18% compliant with the GPs. NREL performed GPs assessments on 3 additional buildings this year.	In FY 2013, NREL will perform two assessments on additional buildings and will develop cost estimates for all buildings assessed to prioritize GP improvements.	L – NREL will meet or exceed this requirement.
2.6	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs and where the work exceeds \$5 million, each are LEED®- NC Gold certification or equivalent.	In FY 2012, NREL received LEED Platinum certification for RSF II.	Construction complete and waiting to receive LEED Platinum certification for the Southern Site Entrance Building. Completed construction of the parking structure designed to LEED platinum standards. Completed construction and waiting to receive LEED Gold certification for the Cafeteria. Continue construction and pursuit of LEED Gold certification for ESIF.	L – NREL will continue to meet or exceed this requirement.
2.7	7.5% of annual electricity consumption from renewable sources by FY 2013 and thereafter (FY 2010–FY 2012 was 5%).	18% of NREL's total power comes from on-site sources. Prior to FY 2012: PV arrays – STM mesa top, RSF I roof top, RSF Visitor parking, STF roof top, and NWTC ground mount. Wind turbines – NWTC DOE/GE, 2 NREL research turbines. Installed FY 2012: 3 PV arrays at the STM site, including RSF II, roof mounted 408 kilowatt (kW); parking garage southern facade and roof mounted 1,153 kW; and the Southern Site Entrance Building (SSEB), roof mounted 15.28 kW.	NREL will continue to look for opportunities to generate or purchase renewable energy.	L – NREL will continue to meet or exceed this requirement.
3.1	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline.	Alternative fuel use has grown 135% since 2005.	NREL's goal is to transform its fleet such that 100% of all non-exempt vehicles are AFVs. The laboratory will continue working with GSA and DOE to increase the number of AFVs in the fleet.	L – NREL will continue to meet or exceed this requirement.
3.2	2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline.	Petroleum use percentage declined in FY 2012. Petroleum fuel usage has grown 55.9% since 2005.	Complete installation and operation of on-site E85 fueling tank.	M – Management Risk: Disposition of low-mileage, AFVs to meet the Secretary's vehicle reduction goal increased petroleum use. Lack of E85 fueling stations in proximity to NWTC makes use of alternative fuel a challenge at that site.
3.3	100% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) by FY 2015 and thereafter (2000-2015).	No light-duty vehicles purchased in FY 2012.	NREL's goal is to transform its fleet such that 100% of all non-exempt vehicles are AFVs. Continue to acquire replacement AFVs for petroleum vehicles as needed—planned replacement of 3 high petroleum use SUVs with smaller AFVs.	L – The laboratory will continue to work with GSA and DOE to increase the number of alternative fuel vehicles in the fleet.

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Performance Status in FY 2012	Planned Actions and Contribution in FY 2013	Risk of Nonattainment High (H), Medium (M), Low (L)
3.4	Reduce fleet inventory of non-mission critical vehicles by 35% by 2013 relative to a FY 2005 baseline.	To date NREL has disposed of 8 vehicles. This reduction represents 100% of the planned fleet reduction of non-mission critical vehicles.	No additional actions planned. All remaining NREL fleet vehicles are mission critical.	L – NREL has met this requirement.
4.1	26% potable water intensity (gal per GSF) reduction by FY 2020 from a FY 2007 baseline.	Reduced water intensity by 30% from FY 2007 baseline. Performed EISA energy and water audits on three buildings.	In FY 2013, NREL will undertake an effort to perform additional EISA building audits on our campus. These audits will be used to identify energy and water savings opportunities within and around our buildings. Information from the FY 2012 water audits will also be used to develop recommendations for future funding needs and building retrofit projects targeted at reducing campus potable water use. Additionally NREL will update the water management plan with detailed strategies and actions to meet the target water intensity goals.	M – Technical Risk: To make ESIF the world's most energy efficient data center, a large amount of water will be needed for cooling, which offsets electricity use.
4.2	20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2020 from a FY 2010 baseline.	NREL does not use ILA water.	NREL will continue to explore opportunities as they become available to utilize non-potable water sources for our campus.	L – Unless reuse water becomes available, NREL will not consume ILA water.
5.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris, by FY 2015.	Diverted 81% of campus waste from landfill. Included biomass waste from Café and Integrated Biorefinery Research Facility (IBRF). Performed two pollution prevention assessments. Participated in SITES program.	Perform detailed evaluation of chemical life cycle at NREL. Perform on-site waste audits to analyze waste stream and identify opportunities for additional reduction. Complete Sustainable SITES program. Perform 2 pollution prevention assessments in FY 2013. Create Landscape Maintenance Plan.	L – NREL will continue to meet or exceed this requirement.
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015.	Diverted 88 % of construction waste from landfill in FY 2012.	Sustainable NREL will continue to track data and enforce subcontractor SOW requirements for all construction projects in FY 2013.	L – NREL will continue to meet or exceed this requirement.
6.1	Procurements meet sustainability requirements and include sustainable acquisition clause (95% each year).	Finalized and implemented Policy 10-1 as well as PCard, and Purchase Request procedures. Hosted a series of meetings to increase the visibility of green office-supply product selection with NREL staff and provide education on preferred purchasing procedures. Collaborated with CADD0 to host a green office supply fair featuring new product vendors and technologies for staff. Implemented the green cleaning janitorial contract campus wide and conducted audits.	Roll out new training for PCard users/approvers. Complete the business systems reporting update to accurately reflect sustainable acquisitions.	L – NREL will continue to meet or exceed this requirement.

SUMMARY TABLE OF GOALS AND TARGETS

SSPP Goal	DOE Goal	Performance Status in FY 2012	Planned Actions and Contribution in FY 2013	Risk of Nonattainment High (H), Medium (M), Low (L)
7.1	All data centers are metered to measure a monthly Power Utilization Effectiveness (PUE) of 100% by FY 2015.	NREL's RSF data center measures monthly PUE.	NREL will continue to optimize data center PUE operations and performance using measured monthly PUE.	L – NREL will continue to meet this requirement.
7.2	Maximum annual weighted average Power Utilization Effectiveness (PUE) of 1.4 by FY 2015.	PUE for the RSF data center is 1.13.	NREL will meet or exceed a world class PUE (less than 1.4). The new Energy Systems Integration Facility data center (FY 2013) has been designed to operate as energy efficiently as possible with a target PUE of 1.06.	L – NREL will continue to meet this requirement.
7.3	Electronic Stewardship: 100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY 2012.	Power management is enabled on 100% of devices.	Continue to maintain Platinum-level FEC designation.	L – NREL will continue to meet this requirement.
8.0	Innovation & Government-Wide support – Site-specific objectives.	Enhanced behavior agent program and conducted RSF I comfort survey. Entered into discussions for 30 MW offsite wind farm (Power Purchase Agreement). Continued outreach for knowledge sharing with other federal agencies (NASA, DOE, GSA and City of Lakewood). Advanced energy efficiency and governmental support showcasing the RSF to over 40K visitors per year and providing workshops to commercial industry and other government agencies.	Utilize ESIF as a user facility (CRADA and utility companies) to develop clean energy technologies for deployment to the market overcoming market and delivery barriers. Utilize ESIF modeling capacity to assess NREL campus energy reduction strategies. NREL will continue to incorporate innovative strategies to leverage REC purchases and sales to enable economic feasibility for new additional renewable energy and energy efficiency on-site projects. Continue to monitor long-term performance of installed energy efficiency and renewable energy technologies to provide living laboratory case studies. Investigate feasibility of offsite wind to attain net-zero energy campus.	L – NREL will continue to meet this requirement.

GREENHOUSE GAS

NREL scientist Garvin Heath works on data from his life cycle greenhouse gas emissions study conducted by NREL's strategic energy analysis center (SEAC).



GOALS

- (1.1) 28% Scope 1 and 2 GHG reduction by FY 2020 from a FY 2008 baseline**
 - NREL reduced Scope 1 and 2 emissions 84% from the 2008 baseline (including RECs).
- (1.2) 14% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline**
 - NREL Scope 3 emissions increased 12% from the 2008 baseline.

STRATEGY AND PERFORMANCE SUMMARY

NREL has been tracking and reporting greenhouse gas (GHG) emissions for more than 10 years. Our goal is to demonstrate leadership in GHG management by maximizing the use of energy efficiency practices and on-site renewable power, and minimizing impacts associated with all aspects of our operations. NREL continuously pursues new technologies and strategies to reduce GHGs associated with our operations. For Scope 2 emissions that NREL cannot avoid, NREL is committed to purchasing renewable energy certificates (RECs) to neutralize the climate change impacts.

All GHG emissions are reported in the Consolidated Energy Data Report (CEDR) to DOE. NREL's operational boundaries include all DOE-owned facilities, vehicle fleet, equipment, and non-highway vehicles at the STM and National Wind Technology Center (NWTC). NREL leases office space in the Denver West office park, Joyce Street, and the Refuel Facility, which are not under NREL's operational control; however, electricity and natural gas data for these properties are included in the CEDR. NREL also reports Scope 3 emissions for sources outside our organizational boundaries, which are a result of our operations.

FY 2012 PERFORMANCE STATUS

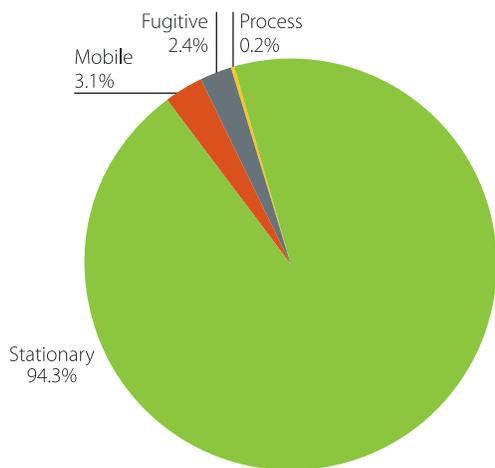
Scope 1

In FY 2012, NREL's Scope 1 emission sources include:

- Stationary emissions: natural gas for heating of DOE-owned and leased facilities
- Mobile emissions: vehicle fleet, equipment, and non-highway vehicles
- Fugitive emissions: fluorinated gases for research, refrigerants for DOE-owned HVAC systems, on-site septic systems at the NWTC and Solar Radiation Research Laboratory (SRRL)
- Process emissions: dry ice for laboratory research.

Stationary Emissions

More than 90% of NREL's Scope 1 emissions are from stationary combustion. These emissions are primarily due to the use of natural gas for the generation of heat and hot water for our DOE-owned



Scope 1 emissions FY 2012

and leased buildings (for more information see the Energy Section). NREL's on-site Renewable Fuel Heat Plant (RFHP) decreased the need for natural gas purchases this year, however, overall emissions increased 20% from FY 2011, but are almost 2% below the 2008 baseline. The increase is due to three main factors: (1) higher ventilation rates in the laboratory spaces, requires more heating in those spaces; (2) in addition, the new wing of the Research Support Facility (RSF II) became occupied, increasing the overall heating demand (these two factors increase the heating demand by 29,000 therms); (3) finally, temporary heating in the new Energy Systems Integration Facility (ESIF) increased heating demand by 150,000 therms.

For consistency with the Facilities Information Management System (FIMS) database, NREL is now reporting the Joyce Street property as being DOE-owned in NREL's GHG inventory. NREL does not have access to natural gas for the remaining leased spaces; therefore, this is not reported.

Mobile Emissions

NREL's mobile emissions represent just over 3% of NREL's Scope 1 sources. In FY 2012, emissions from our vehicle fleet decreased 37% from the previous year; however, mobile emissions have increased 65% relative to the 2008 baseline. While NREL is working to acquire more alternative fueled vehicles (AFVs), the lab has increased the number of petroleum hybrid vehicles in the past year, increasing emissions from this source. Also, due to substantial campus growth, utilization of fleet vehicles by staff has increased. An increase in equipment and non-highway vehicle usage also took place in FY 2011 due to improved reporting procedures as well as greater demands for a growing campus. (For more information see the Fleet Section)

Fugitive Emissions

NREL's fugitive emissions make up less than 3% of NREL's Scope 1 source and include fluorinated gases, refrigerants, and emissions associated with NREL's on-site septic systems at the NWTC and SRRL.

As part of continued efforts to decrease the use of SF₆ in FY 2012, NREL modified its contract for new or relocated fume hood commissioning to prohibit the use of SF₆ (see Pollution Prevention section Success Story for more detail).

NREL tracks its refrigerant and fluorinated gas emissions, the purchases of which are monitored in NREL's chemical inventory, using a three-year rolling average. In FY 2012, fluorinated gas and refrigerant emissions decreased 95% from the baseline year. There were no purchases of SF₆ in FY 2012, but NREL did purchase 120 pounds of R-22 refrigerant. On-site wastewater emissions decreased 31% from FY 2011, which is 27% above the baseline year. This is due to a decrease in population being served by NREL's septic systems between FY 2011 and FY 2012, but an overall increase in population since FY 2008.

Process Emissions

A small quantity of dry ice was reported this fiscal year to comply with recent Safety and Investment Protection reporting guidance. These emissions represent less than 1% of NREL's Scope 1 emissions.

Scope 1 Summary

The overall Scope 1 emissions from FY 2012 are 4,279 MTCO₂e, a 27% decrease from the FY 2008 baseline and an increase of just over 15% from FY 2011.

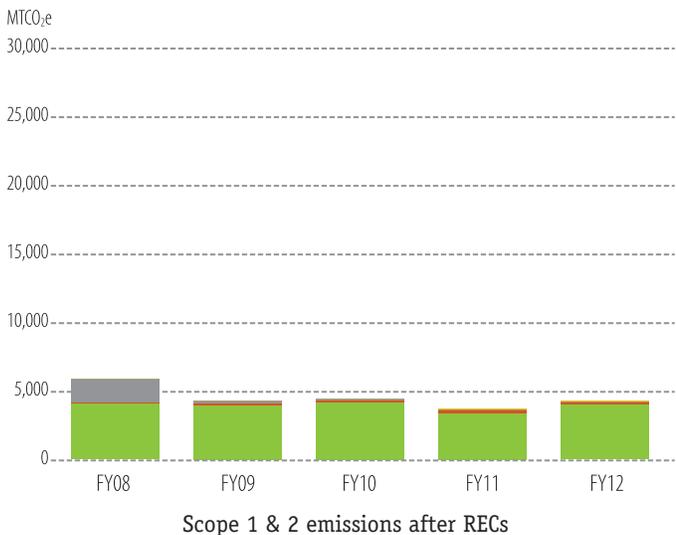
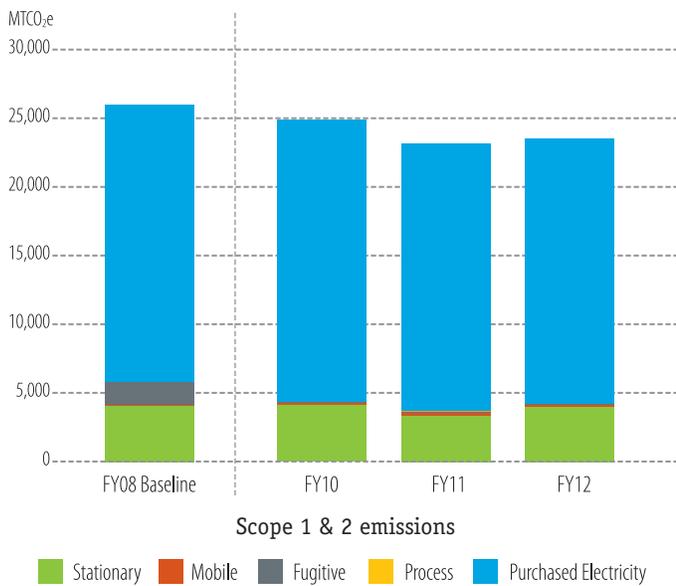
Scope 2

NREL's Scope 2 emissions are associated with purchased electricity for our DOE-owned and leased buildings (see Energy Section). While NREL maximizes the amount of electricity generated on-site, many of these systems were financed through PPAs that required the RECs to be sold. NREL purchases replacement RECs for these systems and has committed to purchase additional RECs to ensure the campus achieves Scope 2 carbon neutrality. In FY 2012, NREL finalized the contract and procured RECs from new Gamesa on-site wind system. When financially practical, NREL retains the RECs for on-site renewable systems.

In FY 2012, 19,475 MTCO₂e were generated from NREL's electricity purchases. This is less than a 1% decrease from last year, and a little over 4% decrease from the FY 2008 baseline. This trend is attributed to the revised Emissions and Generation Resource Integrated Database (eGRID) emissions factors used in the 2012 CEDR. It should be noted, however, that due to the construction and operation of high-efficiency buildings, NREL's electricity consumption has not increased during this timeframe, even though our campus footprint has increased over 70% since 2008. Additionally, NREL purchased Green-e certified RECs to offset all Scope 2 emissions, making NREL Scope 2 carbon neutral again in FY 2012.

Scope 1 and 2 Summary

The following graphs track NREL's overall performance toward meeting Scope 1 and 2 GHG reduction targets. NREL is significantly exceeding DOE's 28% target for Scope 1 and 2 GHG emissions. In FY 2012, NREL decreased total Scope 1 and 2 emissions over 9% from the 2008 baseline. Simultaneously, NREL makes additional efforts to reduce GHG emissions through the purchase of RECs further reducing Scope 1 and 2 emissions to a combined 84% from the 2008 baseline. Scope 1 and 2 emissions increased less than 2% from the previous year, due to an increase in stationary (natural gas) combustion from RSF I coming online as well as additional heat load in the ESIF building.



Scope 3

Transmission and Distribution Losses

In FY 2012, NREL's transmission and distribution (T&D) losses decreased 5% from the baseline and 12% from the previous year due to purchasing less electricity and revised eGRID emissions factors. NREL uses the standard T&D factor of 6.18% to perform this calculation. These emissions represent 16% of NREL's Scope 3 sources in FY 2012. NREL's deployment of on-site renewable energy and highly energy-efficient buildings helps to mitigate emissions from this source.

Business Air Travel

NREL's FY 2012 business air travel emissions increased less than 2% from FY 2011; and FY 2012 business air travel emissions are 51% higher than 2008 baseline levels. These trends are reflective of a slight recovery from travel restrictions in FY 2011 and a 90% population growth since 2008. The data also reflect a more accurate accounting of air miles. In previous years, air miles have been

calculated based on the distances between origin and destination cities. The new mileage is calculated based on the distance of each leg of a flight. For example, if a passenger traveled from Denver to Orlando with a stop in Atlanta, the previous mileage calculation would reflect the distance from Denver to Orlando. The new calculations reflect the actual distance from Denver to Atlanta, then Atlanta to Orlando. This has the effect of changing the distribution of total miles into short, medium, and long haul flights.

Air travel is NREL's largest Scope 3 source, representing over 44% of this category. NREL has extensive teleconferencing and video conferencing systems in place, and is installing video conferencing systems in new office buildings to continue to address this emissions source. NREL has also implemented travel restrictions to operate the lab as efficiently as possible in this economic time, which will also help to curb these emissions.

Business Ground Travel

In FY 2012, business ground travel increased slightly—1% from the previous year, but emissions remains 68% lower than the FY 2008 baseline. This drastic reduction is due to improved data availability for cars rented on business travel, allowing the use of an advanced GHG calculation methodology in lieu of the default methodology for this emissions source. This improved level of detail provides better accuracy for NREL's reporting on business ground travel emissions. This category represents less than 1% of NREL's Scope 3 emissions. To manage emissions from this source, NREL works to educate staff on available alternatives to ground travel including teleconferencing and video conferencing. NREL's rental car policy also allows the use of mid-size AFVs or hybrids when available. For FY 2012, 92% of the cars rented on business trips were in the compact category, while less than 6% of the vehicles rented were midsize. The remaining 2.4% were full-size vehicles, minivans, and SUVs.

Employee Commuting

Employee commuting represents 36% of NREL's Scope 3 emissions. In FY 2012, commuting emissions increased 8% from the previous year which corresponds to an 8% increase over our FY 2008 baseline as well. There was an overall increase in miles traveled for commuting and those miles were distributed across various modes of transportation according to an FY 2011 commuter survey that identified mode split. The reasons for the overall increase in commuting miles may be due to factors such as new staff living farther from the lab and/or some current staff moving farther away from the lab.

NREL's 2011 commuter survey provided improved data on staff commuting modes as well as adoption of telecommuting and alternative work schedules (AWS). This information provided an updated perspective on staff commuting behaviors, of particular importance since staff levels have grown 90% since 2008. The survey showed a shift away from single occupant vehicle commuting. Survey responses also indicated single occupant vehicle trips decreased to 75% of commute trips from 81% in 2008.

The reduction in single occupant vehicle trips was complemented by increases in alternative commuting methods such as bicycling, carpooling, and public transit. Additionally, 19% of the survey respondents reported telecommuting at least one day per week with an additional 4% reporting telecommuting more than one day per week. Combined, this represents more than 5% of NREL's total commute trips. According to the survey, approximately 25% of NREL staff work an AWS—4-10s or 9/80. (4-10s allow a four 10-hour day work week; 9/80 is a two-week schedule of eight 9-hour work days and an 8-hour day, allowing a day off every two weeks). A copy of the FY 2011 Commuter Survey has been provided separately to the Sustainability Performance Office.

NREL offers multiple commuting programs to its employees in order to reduce the lab's Scope 3 commuting emissions. Those programs include:

- Free public transit passes
- A rideshare website to find carpools and vanpools
- Vanpool vouchers
- Bicycle-friendly infrastructure (bicycle parking, maintenance and repair stations, and showers)
- Free shuttles to move employees between NREL facilities and to connect to public transit routes
- Flexible work practices such as:
 - Telecommuting
 - Compressed work weeks or alternative work schedules (AWS).

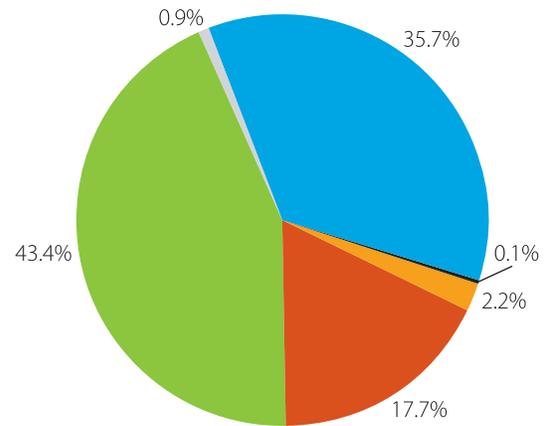
For many years, NREL has offered incentive parking to staff who participate in carpools or vanpools. With the completion of the new parking garage, NREL has added new incentive parking for low emitting vehicles. This "green vehicle" program applies to other buildings on campus as well. Green vehicles are identified by the U.S. Environmental Protection Agency's (EPA) Smart Way certification program.

Contracted Wastewater Treatment

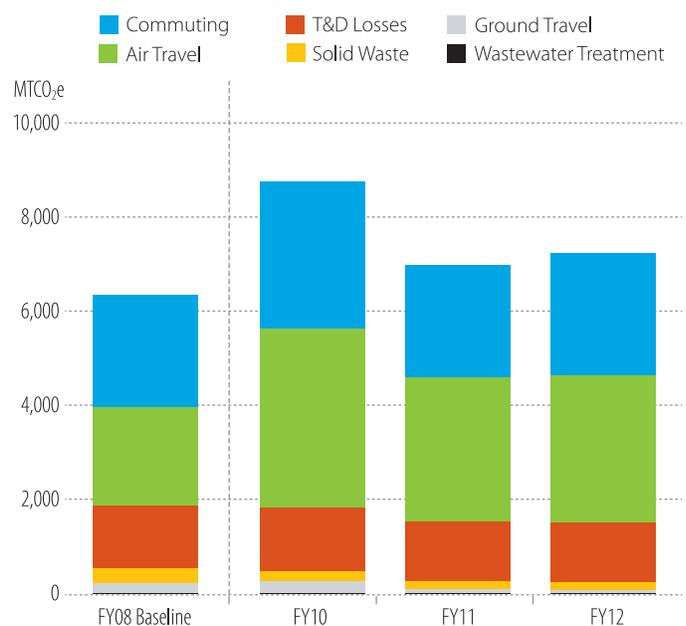
NREL's emissions from contracted wastewater treatment increased in FY 2012—27% from the baseline, but decreased 31% from FY 2011. These emissions are calculated on a population basis, so the substantial growth NREL has experienced is reflected in this increase. Wastewater emissions make up less than 1% of NREL's Scope 3 emissions, so the increase does not significantly contribute to overall emissions from this scope. Increased adoption of teleworking and AWS at NREL are helping to manage emissions from this source.

Contracted Waste Disposal

NREL's contracted waste disposal comprises 2.3% of the overall Scope 3 emissions. In FY 2012, emissions from this source decreased 41% from the previous year and 53% from the 2008 baseline. These reductions demonstrate the effectiveness of our campus-wide composting program, which was rolled out in FY 2011, and staff training on appropriate disposal methods for all waste generated on campus (see Pollution Prevention Section).



Scope 3 emissions 2012



Scope 3 emissions continue to decrease on a per capita basis

Scope 3 Summary

In FY 2012, NREL's Scope 3 emissions were 7,259 MTCO₂e—representing a 2% increase from FY 2011. However, due to campus growth, a 14% increase in these emissions has occurred relative to the 2008 baseline. On a per capita basis, however, NREL's Scope 3 emissions continue to decrease—with a reduction of over 41% from 2008.

Total GHG Emissions

NREL's overall emissions have increased in FY 2012—15% from last year, but remain almost 84% below 2008 emissions. In FY 2012, the majority of our emissions, 63%, came from the Scope 2 purchase of electricity. These emissions are offset in their entirety through the purchase of RECs. Scope 3 represents the next largest emissions source, comprising 23% of all NREL's emissions. Through campus policies and programs that address travel and commuting, NREL is working to mitigate this source. The final category, Scope 1,

represents 14% of NREL's overall GHG emissions. Through enhanced performance of the RFHP and the construction and operation of efficient buildings, NREL continues to decrease emissions from these sources.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.....

Scope 1

NREL will continue to optimize performance of the RFHP to reduce our natural gas requirements for the campus. NREL will also work to reduce emissions from our vehicle fleet through implementation of a no-idling policy, working to acquire more AFVs as mission appropriate, and annually evaluating fleet reduction opportunities in light of changing mission requirements (see Energy and Fleet Sections).

NREL has not purchased SF₆ since 2009 and uses only nominal quantities for research purposes (SF₆ use contributed to 1% of all Scope 1 emissions this year). Transmission-electron microscopes off-gas SF₆ only when serviced. At that time, the contractor contains as much SF₆ as possible in the equipment, and the contractor retains the captured material. NREL is working to replace the use of SF₆ for fume hood testing with nitrous oxide, so a capture program will not be needed. NREL will also work with building energy efficiency researchers to find suitable alternatives to SF₆ for building commissioning tests.

Scope 2

In FY 2012, growth continued at NREL with the construction of RSF II, the Cafeteria, parking garage, the SEB, and a 5 MW dynamometer facility. With each campus addition, NREL upholds the highest standards for energy efficiency and deployment of on-site renewable energy (see Energy and High Performance Sustainable Buildings Sections). Due to the construction of these on-site facilities, NREL will vacate three leased spaces and move staff to DOE-owned facilities; however, this growth will increase campus electricity use. To combat this increase, NREL will look for opportunities to improve energy efficiency of existing buildings through Energy Independent Security Act (EISA) audits, deploy additional on-site renewable energy, and also purchase RECs to ensure all Scope 2 emissions are offset (see Energy Section). As a long term goal NREL will work to decrease REC purchases as additional on-site renewable energy installations are constructed on campus.

Scope 1 and 2 Summary

NREL anticipates continuing to exceed DOE's reduction target for Scope 1 and 2 emissions through efficiency measures and the purchase of RECs to completely offset Scope 2 emissions.

Scope 3

Transmission and Distribution Losses

NREL will continue to identify methods to reduce campus electricity use through energy efficiency improvements, deployment of high-performance buildings, and on-site renewables. These measures will help to reduce both Scope 2 emissions and emissions from T&D losses. T&D losses, however, represent a

challenging category for NREL. While RECs can be used to offset Scope 2 emissions, they cannot offset T&D losses. With the ESIF High Performance Computer coming online in FY 2013, NREL anticipates emissions from this source to increase.

Business Air and Ground Travel

Air travel poses a challenge for NREL given the dramatic population growth experienced since 2008. A certain degree of travel is necessary to support NREL's mission. To mitigate these impacts, NREL will continue enhanced campus-wide video conferencing programs in FY 2013 to reduce travel by providing additional outreach and education to staff and increasing video conferencing capabilities. Additionally, NREL will continue to look for other opportunities to reduce our air travel beyond what is required for mission-critical activities. NREL will also investigate opportunities for improved ground travel data collection methods that could potentially identify areas for further ground travel reductions.

Employee Commuting

NREL will continue to offer programs to encourage the use of alternative commuting modes including telecommuting, AWS, carpool and vanpool, bicycling and public transit. NREL will also continue to provide free public transit passes, vanpool vouchers, and shuttles. Notably, with the opening of the RTD's new West Corridor Light Rail line in FY 2013, NREL plans to provide shuttle services to connect the light rail line, which will run between Denver and Golden, with the STM campus. It is anticipated that more NREL employees will take advantage of public transit when the light rail is available. A commuter survey is planned for FY 2014 in order to update information on the modes of transportation used by employees.

Contracted Wastewater Treatment and Waste Disposal

While GHG emissions from wastewater are a function of population, NREL makes every effort to reduce the amount of sewage through the use of high efficiency, low flush or low flow toilets, urinals, and faucets. These products are in NREL's design standards for all new construction and remodeling of existing buildings. Additionally, NREL's support for telecommuting and AWS will decrease the load on the municipal wastewater system.

NREL's goal is to become a near-zero waste campus. To support this goal, NREL will continue to provide staff training through the Near-Zero Materials Waste program and roll out sustainable purchasing practices. In FY 2013, NREL will continue to perform audits of campus waste to identify problem areas and target additional efforts (see Pollution Prevention Section).

Scope 3 Summary

In spite of NREL's measures to promote campus efficiency of energy, waste, commuting, and travel, NREL expects Scope 3 emissions to continue to increase. This increase is a result of the substantial population and campus footprint growth since the baseline year of 2008. On a per capita basis, however, NREL will continue to work to decrease emissions from the Scope 3 category by implementing available measures to support DOE's reduction goal.

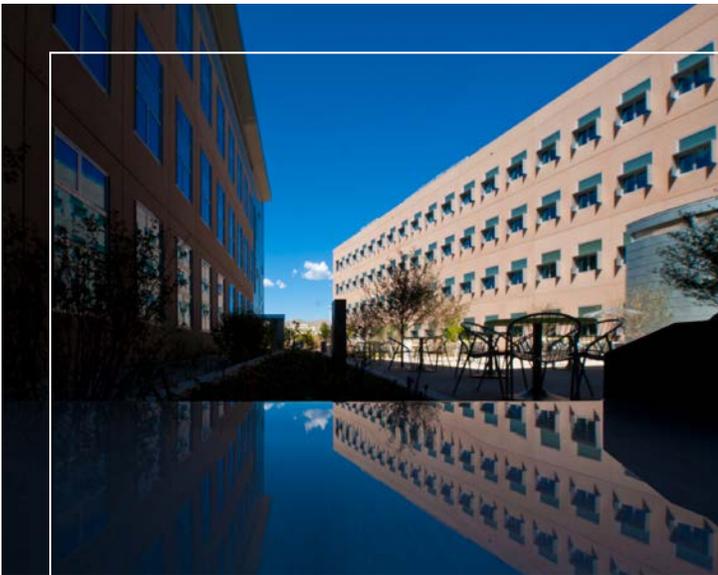
MEASURABLE GOALS

In FY 2013, NREL will:

- Provide shuttle service to RTD's new West Corridor Light Rail Line
- Explore the feasibility of implementing an on-site bike share program
- Develop a STM campus bicycle and pedestrian facility map for use on NREL's intranet site
- Develop and submit application for recognition as a "Best Work Places for Commuters"
- Continue to incentivize and educate staff on employee commuting alternatives
- Explore feasibility of implementing improved data collection methods for assessing ground travel impacts
- Continue to purchase RECs to offset all Scope 2 emissions.

HIGH PERFORMANCE SUSTAINABLE BUILDINGS

Energy efficiency features at the RSF include daylighting, low-emissivity windows, building orientation, super insulation, and high mass structure.



GOALS

(2.4) Cool roofs, unless uneconomical, for roof replacements unless project already has CD-2 approval. New roofs must have thermal resistance of at least R-30.

- Cool roofs are on 59% of NREL campus, a 15% increase from FY 2011.

(2.5) 15% of the number of existing buildings greater than 5,000 gross square feet (GSF) are to be compliant with the Guiding Principles (GPs) of HPSB by FY 2015.

- NREL currently has four buildings (18%) compliant with the GPs.
- NREL performed GPs assessments on three additional buildings this year.

(2.6) All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs.

- RSF II received LEED Platinum certification.
- RSF I received ENERGY STAR certification.
- Construction is complete for South SEB and Cafeteria. Both projects are tracking LEED Platinum ratings and are in final review to receive LEED certification.
- Construction is complete for the parking garage designed to LEED Platinum standards.
- ESIF is nearing construction completion and will attain at least LEED Gold certification, currently tracking LEED Platinum.

STRATEGY AND PERFORMANCE SUMMARY

NREL capitalizes on every opportunity to integrate the principles of high-performance design into our new and existing buildings. In this effort, NREL provides leadership by integrating energy efficient and renewable energy technologies into our new buildings, using our campus as a showcase for our research. NREL's Campus Master Plan and established policies promote sustainable design, operations, and maintenance practices. NREL has committed to DOE's goal of achieving Leadership in Energy and Environmental Design (LEED) Gold or Platinum certification for all new construction and exceed American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2004 requirements. NREL is also committed to upholding the new Better Buildings Initiative to make commercial and industrial buildings at least 20% more energy efficient by 2020 and accelerate private sector investment in energy efficiency.

COOL ROOFS

In FY 2012, the number of cool roofs at NREL increased 15% over the previous year through roof replacement and new construction. Currently more than 274,000 ft² of roof surfaces have at least R-30 insulation or are covered in photovoltaics (PV) or reflective surfaces. With the FY 2012 improvements, 59% of the NREL campus now has cool roofs. This improvement was the result of roof replacement projects on existing buildings as well as new high-performance building construction that included cool roof and PV specifications.

GUIDING PRINCIPLES (GP)

NREL uses the EPA Portfolio Manager tool for the assessment and management of GP compliance. All checklists, with supporting documentation, are maintained in this tool and are used to ensure FIMS sustainability fields are accurate. NREL currently has 22 owned and leased buildings over 5,000 ft² that make up the candidate pool for the Guiding Principles. In FY 2012, NREL has four buildings that meet 100% of the GPs for high performance sustainable buildings: RSF I, RSF II, Integrated Biorefinery Research Facility (IBRF) West, and the Science and Technology Facility (S&TF). With these four buildings, NREL is currently 18% compliant and exceeding the requirements of this goal.

LEED CERTIFICATION STATUS		
Building	Status	LEED Certification
RSF I	Completed in FY 2011	LEED Platinum awarded FY 2011
IBRF	Completed in FY 2011	LEED Gold awarded FY 2011
RSF II	Completed in FY 2012	LEED Platinum awarded FY 2012
SEB	Completed in FY 2012	LEED Platinum anticipated
Parking Garage	Completed in FY 2012	Designed to LEED Platinum standards*
Cafeteria	Completed in FY 2012	At least LEED Gold anticipated
ESIF	FY 2013 completion	At least LEED Gold anticipated

* Parking garage was not intended to include occupiable spaces. Therefore, it was not constructed with plumbing and ventilation systems and is not eligible for LEED certification.

In FY 2012, NREL also continued efforts to perform GP assessments of our existing buildings. Three assessments were performed this year on the following facilities: Field Test Laboratory Building (FTLB), NWTC Administration Building, and the IBRF East (previously Alternative Fuel Use Facility). As part of these assessments, NREL determined the percent compliance and necessary actions to achieve full compliance for these facilities. Based on this information, cost estimates will be developed to bring these facilities into full compliance. Currently, 55% of NREL's buildings have been assessed or are in full GP compliance. All new construction at NREL will be fully GP compliant through achievement of LEED Gold or higher certification.

LEED CERTIFICATION

NREL is committed to meeting or exceeding DOE's goal to achieve LEED Gold certification on all major new construction. As part of NREL's commitment to building high performing and energy efficient buildings, in FY 2012 one new building received certification and the construction of three other high-performance buildings was completed. The projects that have been completed or are in progress are indicated above.

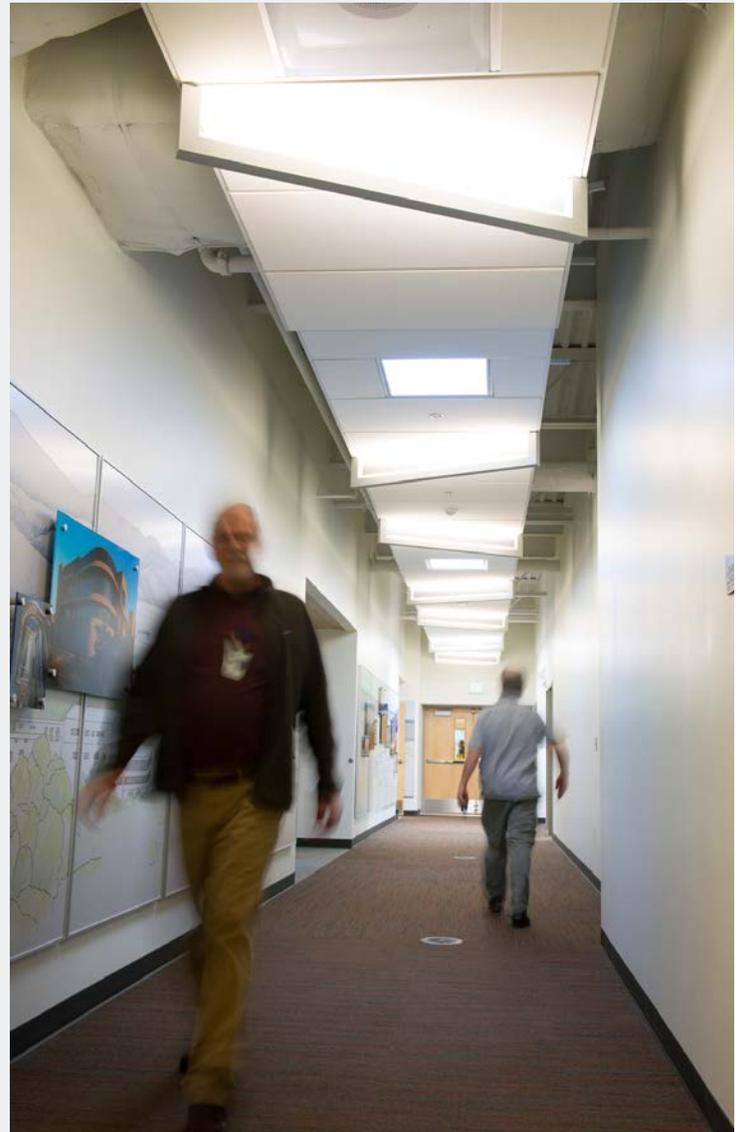
NET-ZERO ENERGY BUILDINGS

The energy use and costs of a building depend on the complex interactions of many parameters and variables. New construction facilities at NREL set stringent energy use intensity (EUI) targets first and utilize whole-building energy simulations to meet this consumption goal throughout the design process. It is critical to thoroughly evaluate all the interactions between the envelope, HVAC system, and design features to inform and optimize energy efficiency strategies. NREL's philosophy for achieving net-zero energy buildings is to minimize its energy consumption first, and then use PV (or other building integrated technology) to offset

those energy requirements. PV panels are, for most contemporary construction projects, enticing but not affordable, with costs of \$5-\$6/ft² for large scale projects, including tax incentives.

To reduce start-up costs and implement this strategy for the RSF complex, NREL entered into a power purchase agreement (PPA) for the procurement of a 449 kW system, installed on the roof of the RSF I shortly after the building was complete. A second 524 kW system installed over the visitor parking lot in the form of shade canopies began operating in July 2011. The third system is the addition of 408 kW roof mounted system on the RSF II. Additionally, a 1,156 kW array was installed on the rooftop and the southern façade of the parking structure and is anticipated to be operational in FY 2013 once agreements with Xcel Energy Utility of Colorado are signed. The second and third systems were funded by the American Recovery and Reinvestment Act (ARRA). The three systems totaling more than 1.6 MW are designed to meet the RSF's energy target of 35 kBtu/ft²/yr with a small buffer, based on a site energy definition.

NREL's Southern Site Entrance Building (SSEB) is the second facility constructed, in operation as of February 14, 2012, as a net-zero building. It combines energy efficiency technologies and a 15.28 kW roof mounted PV array that NREL purchased within the project construction budget. NREL will be collecting data and monitoring its performance to demonstrate its net-zero energy performance annually.



The RSF II, a 143,341 ft² addition to RSF I, houses Class A office space and 550 occupants. Construction was completed in November 2011 at a cost of \$60,910,000. This facility received LEED Platinum certification on September 10, 2012. After monitoring the performance of RSF I, opportunities were identified to increase its energy efficiency by an additional 17%. RSF II energy building performance is operating 13.26% better than modeling projections based on a six month time period. Its energy building use EUI is on target to being 11% more efficient than RSF I.

Additionally, RSF II houses two unique campus amenities: the Information Commons and the Wellness Center. The Information Commons includes the NREL Library and a variety of workspaces, including two huddle rooms with white boards, tack boards, and LED monitors, and several large tables in the main room for collaborative group discussions. The NREL Library serves the entire lab with providing access to an extensive array of information resources that support the laboratory's research, analysis, and deployment efforts. The Wellness Center has aerobic machines (treadmills, spinning bikes, stair climbers), free weights, and exercise bikes. The center also features a separate room for aerobics and yoga classes. Locker rooms provide showers, changing areas, and lockers to further enhance opportunities for active lifestyles whether commuting to work by bike, hitting the trails for running and walking, or exercising at lunchtime.

Clockwise from top: artist rendering of RSF II; solar tubes in the hallways of the RSF II provide daylight; the Information Commons.



Having parked off-site for 18 months, NREL staff enthusiastically welcomed the celebration of opening day for the parking garage on February 14, 2012. NREL's parking garage project is proving that large conventional garages can be innovative and perform sustainably. This structure meets staff needs with up to 1,800 parking spaces with over 180 preferred parking spaces for NREL designated "Green Vehicles" that meet specific environmental thresholds or carpool and vanpool vehicles. These spaces are designed to incentivize staff use of more eco-friendly vehicles and/or behaviors. Vehicles are eligible for an NREL Green Vehicle decal if it is on the U.S. Environmental Protection Agency's (EPA) SmartWay Certification list. The SmartWay designation indicates the vehicles with the best environmental performance compared to all other vehicles, where EPA certifies that these vehicles have exceeded environmental thresholds on the air pollution and greenhouse gas scores.

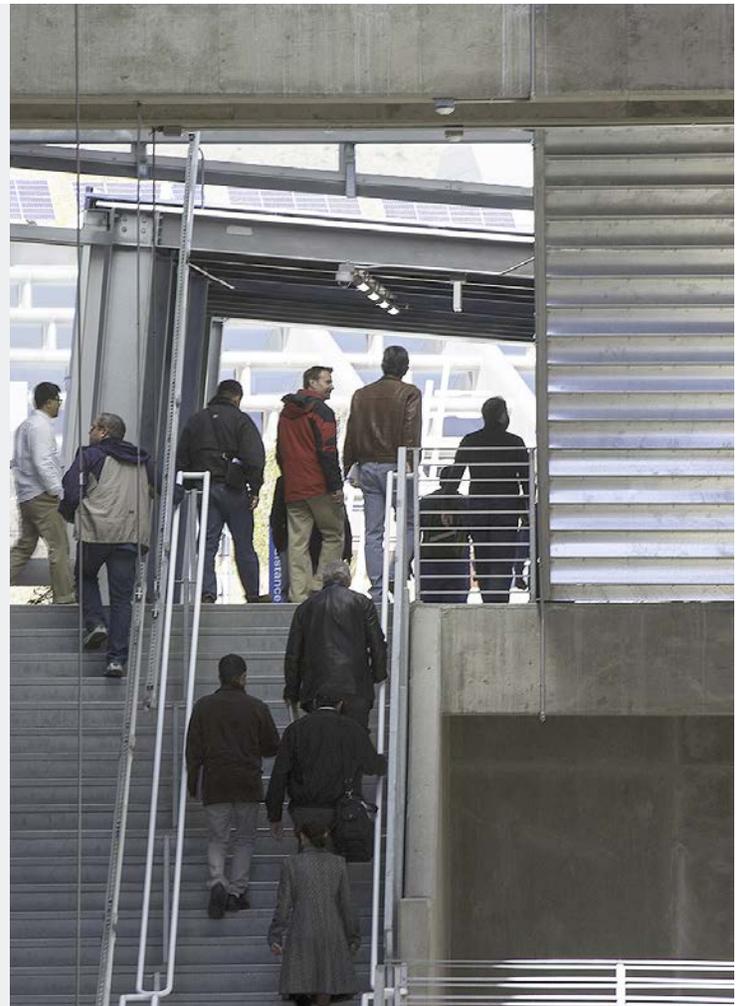
Additionally, 36 electric vehicle charging stations were installed intended for use by fleet and government vehicles. As part of our ongoing research efforts as a "living laboratory" in addition to fleet and government vehicles use, staff will also be permitted to use the charging stations for personal vehicle charging. Staff use of the charging stations will provide robust data that supports research efforts related to NREL's plug-in electric vehicle (PEV) testing and energy systems integration hardware-in-

the-loop testing activities. The charging infrastructure in the garage will be virtually connected to the new Energy Systems Integration Facility (ESIF). In doing so, NREL and its partners will be able to use this infrastructure to develop and test new load management controls and to test the impact of different PEV charging scenarios on the utility network using actual PEVs and charging infrastructure.

In the summer of July 2012, the parking structure operated at an energy use intensity of 107 kBtu/space/yr. The annual projection, which is expected to rise due to high electricity use in the winter months, is closer to 160 kBtu/space/yr. If achieved, the parking structure will operate using 90% less energy than an ASHRAE Standard 90.1–2007.

To achieve deep energy savings on the parking structure best practices, best-in-class equipment options, and case study comparisons were utilized. To meet an annual energy goal of 0.15 kBtu/ft²/yr the design team evaluated lighting, security, equipment room and elevator fans, parking management, and parasitic loads. The energy goal was stringent enough to preclude mechanical ventilation for the garage itself. The design maintains an approximate 40% façade openness that allows natural ventilation on all levels.

Lighting is typically the largest load, particularly for naturally ventilated structures. To reduce the lighting load to almost zero during daylight hours, the façade is perforated metal with 40% openness, distributed



to block headlights and provide some weather protection while also allowing light to penetrate the facility. All remaining façade space is either open air or glass for enclosed stairs. The open façade would not be able to meet a full daylighting effort in the center of the space, so the structure has a light well on each side. Daylight modeling shows, and operation substantiates, that only a few places in the structure, such as under stairs, need to be electrically lit between sunrise and sunset (based on 1 foot candle (fc) minimum illuminance).

The installed Light Power Density (LPD) is just under 0.05 W/ft². This is achieved with one 71-Watt LED fixture per bay (two-direction driving aisle with 90-degree parking stalls on both sides) with additional lighting for stair and elevator areas. The lighting fixture provides distribution necessary to meet the performance specifications of 1.5 fc average, 1fc minimum, 4:1 average minimum illuminance ratios (without cars), and reduced glare potential, similar to recommendations in the High-Efficiency Parking Structure Lighting Specification (PNNL 2010). The electric lighting is controlled by strategically placed daylight sensors and occupancy sensors. Occupancy sensors are infrared type and take the lights to full off when no occupancy is detected. Light fixtures are zoned to provide a pathway of light for each entering occupant. An advanced lighting control system allows for ease of commissioning/re-commissioning by convenient regrouping and assigning fixtures and

Facing page: north entrance; this page, clockwise from top: PV garage roof installation; interior staircase; east gate entrance to the garage.

sensors, depending on occupant patterns. Emergency lights are on a generator, so battery backup is not needed. Fail-to-on mechanisms are installed. Miscellaneous equipment includes fans for equipment rooms, elevator lighting and ventilation, phones and cameras for security, heat trace for drainpipes, heaters for cameras and fire alarm pull stations, and lighting and fire alarm controls. The estimated annual use breakdowns for elevators and miscellaneous equipment are 16% and 55%, respectively. The remaining 29% is estimated for lighting.

The highest miscellaneous electric load is due largely to security equipment, which consumes 29% of the total annual energy. These electricity requirements will be offset by renewable energy PV panels on rooftop and south façade; excess power will help offset energy use in the nearby Research Support Facility.



The SSEB was constructed at the end of NREL's new access road located at the southern boundary of the STM campus. Construction for this 1,660 ft² structure was completed in January 2012. The key purpose of this structure is to provide a secure checkpoint for an expected 40% of the employees and visitors entering and exiting the NREL campus. Adhering to the highest standards of LEED, the building maximizes points across every category of the rating system and is anticipated to be certified at the Platinum level. This structure is a net-zero energy building with an extremely stringent energy consumption restriction. Given these parameters, numerous innovative energy efficient technologies are utilized including: natural daylighting, solar PV panels, geothermal heat pump, radiant ceiling slab, underfloor air distribution, triple pane window glazing, thermal mass walls, a low energy mechanical recovery system, and a wind catch tower.

A photovoltaic system has been integrated into the roof in order to offset the annual energy use, making the security structure a net-zero energy building (ZEB). Fifty-four (54) Schott 235 PV panels are currently placed on the roof in order to meet the net-zero requirements of the facility. This system would produce an estimated 16,354 kWh of electricity, which exceeds the ZEB goal by 12%.



The SSEB and entrance to the NREL campus via Moss Street. The SSEB is energy efficient, constructed mostly with recycled materials and features a passive cooling tower.

The as-built energy model demonstrates the security structure is meeting the energy performance goals, using 31.7 kBtu/sf/yr, which equates to 14,639 kWh annually. This demonstrates a 0.9% reduction below an annual energy use goal of 32 kBtu/sf/yr and 14,771 kWh.



The 12,140 ft² cafeteria, completed in May 2012, offers a precedent model for creating a high performing, low-energy consuming, and “state-of-the-art” example of efficient food service. The facility houses numerous ENERGY STAR-rated kitchen appliances and other best-in-class, high-efficiency equipment. The kitchen ventilation system utilizes demand-controlled exhaust hoods that vary air-flow rates based on the amount of heat emitted from the surface of the cooking appliances. This variable flow system, paired with a variable-speed make-up air unit, reduces fan energy significantly. Other efficiency measures include door alarms on the walk-in coolers and freezers, LED lights, and a best-in-class dishwasher that reuses water from the last rinse of a dish cycle to pre-rinse the next load.

To operate and deliver high quality food service and align with the NREL mission, the selection committee emphasized the importance of selecting a vendor whose business processes already integrate sustainable operations. In July 2012, a joint venture team of UR/Compass Group was awarded the contract. In addition to supporting NREL’s lab-wide programs for green cleaning and material management of recycling and composting, our selected vendor engages in some unique sustainability programs that are in full practice:

Buying Local Products to Support Family Farms. Supporting the preservation of the American family farm, reducing the carbon foot print of their supply chain, and giving back to the local communities are central to the

Compass Group’s core values. Compass group defines “local” as typically within a 150-mile radius from the producing facility. They encourage their managers and chefs to build relationships with local farmers and produce distributors to increase local buying and promote seasonally available produce. To ensure food safety and traceability of local produce, their purchasing is done through an approved produce distributor.

Serving Seafood that Comes from Sustainable Sources. Compass Group is committed to protecting the threatened global fish supply. In collaboration with the Monterey Bay Aquarium Seafood Watch program, they established a landmark purchasing policy in 2006 that removed unsustainable wild and farmed seafood from their menus.

Trim Trax. Compass Group has developed a food waste reduction program called Trim Trax—a green initiative that can also cut their food and operating costs. The program tracks and measures food waste at the unit level in the following categories: production waste, over-produced, unused/out-of-date inventory and open category. This aligns with NREL’s waste reduction targets and the emphasis of minimizing trash and composting more. All food production associates have the use of an 18-quart Trim Trax plastic container. All waste is measured and categorized daily at every station before disposal. All results are tracked and submitted to Sustainable NREL quarterly.



The ESIF will soon be the nation's first facility that can conduct integrated megawatt-scale research and development of technologies, components, and strategies in order to safely move clean energy technologies on the electrical grid "in-flight" at the speed and scale required to meet national goals. The \$135 million, 130,000 ft² facility will be complete in FY 2013. It will provide support space for approximately 225 researchers, effectively consolidating activities from several locations at NREL, some of which are in leased facilities.

During the week of March 20 to 23, 2012, a project management construction project review was conducted by the Office of Engineering and Construction Management (OECM) within DOE to verify the project is on track to assess the project's cost, schedule, and technical progress against the approved Performance Baseline. A component of the technical review was a focused LEED peer evaluation to examine project credit solution and submittals to achieve a LEED Gold rating. The LEED peer evaluation recorded their findings to acknowledge that NREL has sought conscientiously to exceed the mandated minimum level of LEED Gold in their attempt to achieve a certification level of LEED Platinum. The current project LEED scorecard is illustrating the possibility of ESIF attaining LEED Platinum certification, but this will not be known until the construction credit submittal review is complete.

This structure requires very innovative strategies for energy efficiency because its program components are so varied. This facility will provide offices, laboratories, and a High Performance Computer data center. The challenge for the design is to simultaneously meet specific building system requirements for each program area while utilizing compatibilities to create synergies for energy efficiency, including:

- Utilizing the recovery water system's waste heat from the data center to be used for heating the offices and high bay laboratory
- Cooling towers for primary cooling for all facilities
- Compressor-free cooling and variable-speed primary pumping in the data rooms
- Active chilled beams for heating or cooling of the offices
- Dedicated outdoor systems
- Daylighting
- Roof mounting systems for solar PV panels.

Outdoor pads are available for testing larger equipment and systems up to the multi-megawatt scale. The ESIF will also contain advanced computational capability to support characterization of solar, wind, hydrogen, building systems, and integrated energy systems, including electricity storage. This information is required to effectively design, engineer, test, and verify technologies for commercial deployment.



Success Story | MONITORING REAL-TIME PERFORMANCE FOR THE RESEARCH SUPPORT FACILITY I

No building can be expected to operate at its potential without paying attention to performance and addressing issues that arise. The operation of the RSF I building includes a thorough measurement and verification process. NREL's Commercial Buildings Group has collected metered data and monitored RSF's performance for the past two years.

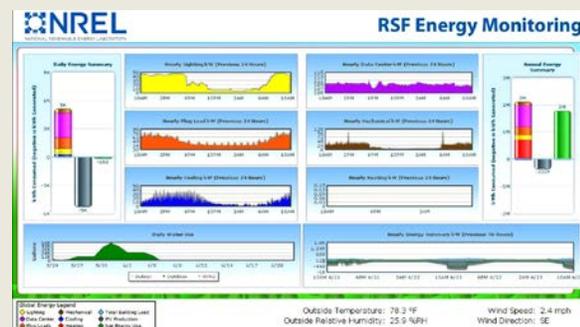
All energy end uses and on-site renewable energy systems are sub-metered. A rich set of actual energy use data has been gathered, analyzed, and compared to the predicted performance from the final as-built energy model. Accounting for modest differences in weather and actual building use, overall building energy use, and end use energy consumption has tracked closely with predictions. After two years of operation, the measured EUI is 35.4 kBTU/ft²/year compared to the energy target of 35.1 kBTU/ft²/year. Of the total 35.4 kBTU/ft², the data center uses 14 kBTU/ft² and the building without the data center is at 21.4 kBTU/ft².

For the RSF I operations team, evaluating the measured end use profiles against the predictions has been critical in aligning operation deficiencies with the energy model end use budgets.

NREL's RSF I is successfully pursuing its objective of being a next generation high performance commercial building. While the specific strategies implemented on the RSF I will vary in applicability to other projects, the overall approach to achieving large energy

savings without additional cost is repeatable and can serve as a blueprint for taking net-zero energy to scale.

In August 2012, an example of third party review, the RSF I received a perfect score of 100 from EPA's ENERGY STAR program for Buildings. To get the designation, a building must rate 75 out of a possible 100 on the EPA's energy performance scale, indicating that the facility performs better than at least 75% of similar buildings nationwide. The new designation comes with another benefit beyond proclaiming our effective use of energy efficiency and renewable energy technologies. It shows that we are making efficient use of all our resources, including taxpayer dollars.



The energy dashboard at the RSF I provides real-time monitoring of energy consumption and renewable energy production from the roof-mounted PV array.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.

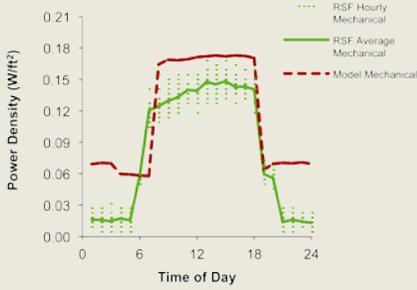
Cool Roofs

All roofs not meeting cool-roof criteria have been evaluated for replacement using a simple payback calculation. At this time, no other existing roofs are economically feasible to replace with a cool roof, unless they are approaching the end of their useful life. The TTF roof will be replaced in the first quarter of FY 2013 with a cool roof, as it has reached the end of its useful life. Future roof replacement projects will be evaluated to determine the cost effectiveness for replacement with cool roofs. Completion of the ESIF, scheduled for FY 2013, will mark further progress by increasing the square footage of cool roofs. Additionally, NREL will be moving out of three leased buildings that do not have cool roofs. These changes will increase the overall cool-roof area on NREL's campus to 284,762 ft² in FY 2013.

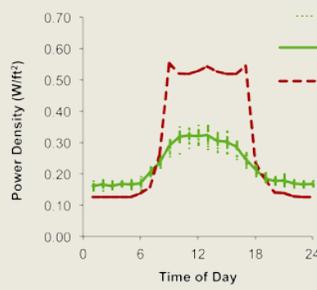
Guiding Principles

NREL is committed to performing annual assessments of existing buildings to identify gaps in achieving GP compliance. In FY 2013, NREL will perform two assessments on additional buildings and will develop cost estimates for all buildings assessed to prioritize GP improvements. Contingent on funding availability, NREL will work to bring existing buildings into full GP compliance to help move the campus to 100% GP compliance. NREL will also work to include GP requirements in specifications for campus construction and remodeling.

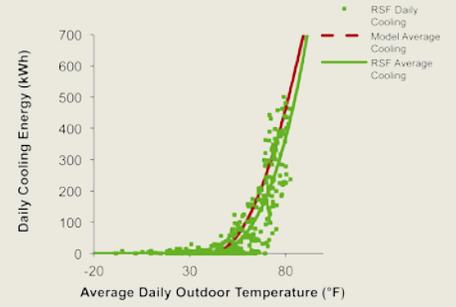
ENERGY MONITORING OF THE RESEARCH SUPPORT FACILITY



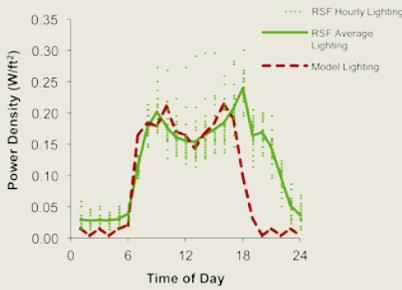
Model vs. actual October 2011 mechanical power density



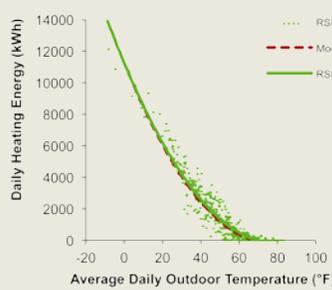
Model vs. actual October 2011 plug load power density



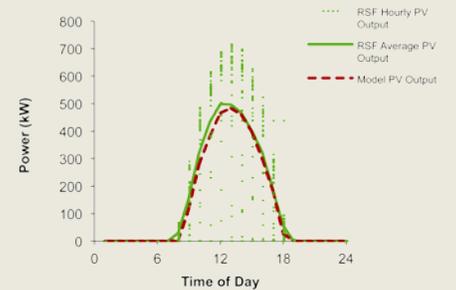
Model vs. actual October 2011 daily cooling power density



Model vs. actual October 2011 lighting power density



Model vs. actual October 2011 daily heating power density



Model vs. actual October 2011 PV output

Through the construction of new high performance sustainable buildings on campus, NREL will continue to add new GP compliant buildings including the new NREL Cafeteria and ESIF, which will achieve compliance in FY 2013. NREL's plan for compliance is shown in the figure below. All GP compliance will be managed in the EPA Portfolio Manager tool.

LEED Certification

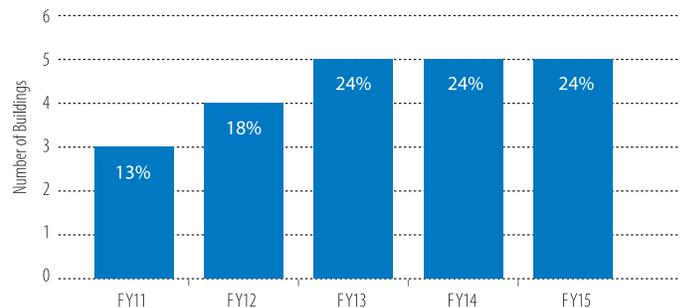
In FY 2013, construction of ESIF will be complete and construction activity credits can be submitted to complete LEED certification review.

MEASURABLE GOALS

In FY 2013 NREL will:

- Conduct two additional GP building assessments
- Develop cost estimates for all assessed buildings to achieve GP compliance
- Incorporate GP requirements into construction specifications

- Complete construction for ESIF and receive at least LEED Gold certification
- Receive LEED Platinum certification for SSEB and at least LEED Gold certification for the Cafeteria.



Plan for Guiding Principles Compliance



BUILDING, ESPC, REGIONAL AND LOCAL PLANNING ENERGY

The NREL cafe, completed in May 2012, offers a precedent model for creating a high performing, low-energy consuming, and “state-of-the-art” example of efficient food service.

GOALS

- (2.1) 30% energy intensity reduction by FY 2015 from a FY 2003 baseline**
 - Energy intensity decreased 29% since 2003.
- (2.2) EISA Section 432 energy and water evaluations**
 - NREL conducted EISA evaluations for 50% of total site energy use.
- (2.3) Individual buildings or processes metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015)**
 - NREL connected electricity, hot and chilled water, and natural gas meters in five new buildings to the Energy Dashboard.
- (2.7) 7.5% of annual electricity consumption from renewable sources by FY 2013 and thereafter**
 - On-site renewable-energy sources supply 18.8% of NREL’s total power.

STRATEGY AND PERFORMANCE SUMMARY

NREL’s goal is to establish a campus of the future that showcases the possibilities that efficient use of energy and renewable sources can bring. To support this goal, NREL invests in site design and building development that maximizes energy efficiency and renewable energy opportunities. Where possible, NREL integrates renewable technologies on campus through a variety of financing mechanisms that help to minimize our energy footprint while accommodating campus growth.

FY 2012 PERFORMANCE STATUS.....

Energy Intensity

Electrical energy use in NREL’s DOE-owned facilities increased slightly from FY 2011 (19,600 MWh) to FY 2012 (20,730 MWh). This increase can be attributed to the occupation of RSF II and the IBRF becoming active in FY 2012. Natural gas use in NREL’s DOE-owned facilities increased between FY 2011 (59,900 MMBTU) and FY 2012 (73,410 MMBTU). NREL’s wood-chip fueled RFHP displaced 12,000 MMBTU of natural gas in the reporting period.

NREL has two natural gas-fired boiler plants, in the Solar Energy Research Facility (SERF) and the FTLB, and a wood fired hot water boiler (RFHP) all tied into a the campus’ central heating system. In FY 2012, work was completed to replace inefficient boilers in the FTLB with high-efficiency condensing boilers. The SERF retained its average-efficiency fire tube boilers; however, a new operating scheme has been implemented to minimize the use of these boilers as much as possible. Building automation system programming was rewritten to run the condensing boilers first and to export hot water to the SERF when there is sufficient capacity. Valves were also added so that hot water from the RFHP flows to the SERF to maximize use of the new condensing boilers.

NREL is on track to meet the FY 2015 energy intensity goal, with a value of 183 kBtu/ft²—a 29% decrease from NREL’s FY 2003 baseline. This intensity reduction can be attributed to the completion of RSF II and its addition to the FIMS database in FY 2012, increasing

Success Story | NREL WINS 2012 DOE ESTAR AWARD FOR ENERGY MANAGEMENT

Recognizing the lab's innovation and commitment to sustainability, DOE recently presented NREL with the EStar Award for Comprehensive Energy Management. The winning team—Chris Gaul, Sal Sferrazza, Jennifer Daw, Shanti Pless, and Michelle Slovisky—demonstrated leadership in energy management by modeling and documenting the feasibility and cost effectiveness of renewable energy technologies.

One of the things the team was recognized for was their implementation of the four steps that make up NREL's management methodology:

- *Measuring.* Metering our energy consumption and collecting the data
- *Portfolio Assessment.* Finding opportunities to save energy and estimating how much energy each opportunity could save
- *Establishing Targets.* Taking action to target the opportunities
- *Monitoring and Improvement.* Tracking progress by analyzing data to assess effectiveness of energy savings efforts.

These steps are used to manage both passive and active energy components. Passive components include:

- *Plug loads (energy used by office equipment, lighting, etc.).* 64 watts per office cubicle compared to 300 watts for a typical workspace
- *Equipment modifications or retrofits.* Strategies that reduce energy through energy efficiency
- *Programs and educational outreach.* Informing building occupants on how to save energy in workspaces



- Building occupancy survey. Data regarding occupant comfort used as a basis for building modifications.

Active components include:

- On-site renewable energy systems including wind, photovoltaic, solar thermal, and the Renewable Fuels Heating Plant
- High-performance and net-zero energy building energy modeling to inform design process for new buildings and decisions about energy efficiency and renewable energy technologies and applications
- Site metering of hot and chilled water, electricity, and natural gas
- Energy dashboard system simplifies direct monitoring of NREL's energy consumption and reporting.

NREL's energy management leadership, with its strong emphasis on environmental stewardship, provides a replicable example to other federal facilities and the commercial building sector.

NREL'S ENERGY INTENSITY			
DOE FY15 Goal (BTU/GSF)	NREL FY03 Baseline (BTU/GSF)	FY12 (BTU/GSF)	Energy Change over Baseline (%)
180,521	257,552	182,726	29%

NREL's DOE-owned space by almost 25%. The PV arrays associated with the RSF I and RSF II projects will ultimately provide enough on-site production to make these buildings net-zero energy. NREL's energy intensity data for FY 2012 was reported in the CEDR worksheet for submission to DOE. In addition to the buildings on the STM and National NWTC campuses, NREL also leases several facilities, which are not included in NREL's energy intensity calculation.

In FY 2012, NREL continued entering data into the EPA Portfolio Manager Tool to benchmark our metered building energy performance.

ESPC Initiative Schedule

NREL Site Operations and researchers investigated installing a fuel cell under an ESPC. The project was found not to be economically viable because there was no use for waste heat during much of the year. NREL's electrical service is a reasonable cost and sufficiently reliable to support the research mission.

FY 2012 ON-SITE RENEWABLE ENERGY PRODUCTION

Source	FY12 Energy Produced (MWh)	FY12 Energy Produced (BBTU)	RE as a Percentage of Grid Electricity Use	RE as a Percentage of Thermal Energy Use
Electricity from solar	4,405	9.5	17.25%	N/A
Electricity from wind	389	1.3	1.55%	N/A
Renewable thermal energy	N/A	10.0	N/A	13.0%
On-site total	4,794	20.8	18.8%	13.0%
Purchased RECs from new renewable source	23,037	78.6	81.2%	N/A
Total	27,831	499.4	100%	13%

EISA Audits

NREL reports the Energy Independence and Security Act of 2007 (EISA) covered facility energy use in the CEDR. NREL's covered facilities represent the major energy consumers and opportunities for energy efficiency improvements on NREL's STM and NWTTC campuses. In 2012, energy and water audits were performed on three of NREL's buildings: FTLB, SERF, and S&TF, representing 50% of total site energy use.

NREL's 2012 EISA audits were performed using in-house expertise to evaluate mechanical, water, and plug load systems. NREL provides publicly available guidelines, checklists, and data collection forms to help businesses, government agencies, tribes, and other organizations incorporate energy-efficient products and operations and maintenance practices into existing buildings. These materials were used by NREL to conduct our in-house EISA audits. The EISA evaluations were used to identify potential energy and water conservation measures for implementation. Measurement and verification will be implemented for conservation measures as required to fully understand energy and cost savings associated with their implementation.

Energy Equipment Upgrade

NREL's Central Plant district heat plant was designed in 1996 around simple boilers with at best 80% thermal efficiency. These units reached the end of their service life and were replaced in 2012 with six condensing boilers equipped with controls to maximize overall efficiency. Building Automation System programming uses these boilers as much as possible, leaving older boilers off line. These new boilers have not yet run a heating season so year to year comparisons have not been made.

At this time, the RSF is the only building on campus with a space type that allows for benchmarking in the EPA Portfolio Manager tool. Using Portfolio Manager, NREL achieved ENERGY STAR certification for the RSF I in 2012.

EISA 433

Increasing energy efficiency in building design and mechanical equipment and utilizing on-site renewable energy sources are measures NREL has taken in the construction of new facilities to comply with the goal of fossil fuel reduction. NREL's RSF and ESIF facilities integrate waste heat recovery systems from internal data centers to heat other building spaces such as office and laboratories. NREL's RSF, Parking Garage, and Southern Site Entrance Building produce net-zero energy facilities by integrating energy efficiency technologies and renewable energy technologies (PV array and ground source heat pumps).

Renewable Energy

Supplemental to utilizing energy efficient technologies for offsetting increased energy consumption, NREL installs on-site renewable energy generation on both the STM and NWTTC sites where feasible. To date NREL has met and exceeded the target goal for 7.5 % of annual electricity consumption from renewable sources. NREL's on-site renewable systems, including PV arrays and wind turbines, generated a total of 4,794 MWh in 2012 or 18.8% of NREL's power. In FY 2012, NREL installed three PV arrays at the STM site:

- RSF II, roof mounted 408 kilowatt (kW)
- Parking Garage southern façade and roof mounted 1,153 kW
- Southern Site Entrance Building, roof mounted 15.28 kW.

The NWTTC has approximately 9.2 MW of installed wind turbine capacity. Four major turbines at NWTTC include:

- DOE-installed General Electric 1.5 MW turbine and turbines installed by their respective manufacturers under Cooperative Research and Development Agreements (CRADA)
- Siemens 2.3 MW turbine
- 3 MW Alstom turbine
- 2 MW Gamesa turbine.

The energy produced from the three CRADA turbines is not included in NREL's renewable energy generation. NREL retains the renewable energy certificates (RECs) from the small research turbines and DOE-owned wind turbine at the NWTTC. NREL purchases RECs from Gamesa and Alstom to meet greenhouse gas Scope 2 carbon neutrality.

NREL MAJOR ON-SITE RENEWABLE ENERGY FROM WIND AND SOLAR PHOTOVOLTAIC SOURCES

Location	Source	Date Installed	System Capacity	FY12 Energy Produced (MWh/yr)
STM ST&F	Roof top PV array	2009	94 kW	137.8
STM Mesa top	Ground mounted PV array	2008	720 kW	1,263
STM RSF I	Roof top PV array	2010	449 kW	606.7
STM visitor parking	Roof top PV array	2011	524 kW	305
STM RSF II	Roof top PV array	2012	408 kW	463.6
STM parking garage	Roof top and southern façade mounted PV array	2012	1,153 kW	0
STM SSEB	Roof top PV array	2012	15.28 kW	0
NWTC site	Ground mounted PV array	2009	1000 kW	1,607.4
NWTC site	NREL research turbines	1994	1376 kW	25.9
NWTC site	Siemens wind turbine	2010	1500 kW	2495*
NWTC site	Alstom wind turbine	2011	2300 kW	741*
NWTC site	Gamesa wind turbine	2012	3000 kW	702*
NWTC site	DOE GE wind turbine	2009	1500 kW	363

* Excluded from NREL's power generation because RECs are not retained

NREL's solar thermal installations produced an estimated 10,200 million BTU of renewable thermal energy through solar hot water systems (FY 2012), ventilation air preheating systems, and Trombe walls. NREL's wood-chip fueled RFHP utilizes forest thinnings from Front Range Healthy Forest Initiative activities and other wood wastes to displace natural gas usage for space heating. In FY 2012, the RFHP produced 10,000 million BTU. The RFHP is continuing to improve in performance and is slated for a major upgrade in spring 2013.

Renewable Energy Certificates (RECs)

NREL purchased 23,037 MWh of RECs through the Western Area Power Administration's Federal Agency Master Purchase Agreement to cover all the electricity used on-site and achieve carbon neutrality for indirect (Scope 2) greenhouse gas emissions associated with site operations. NREL's purchased RECs represent the renewable attributes of renewable energy systems built in other locations. Through the purchase of RECs, NREL supports those renewable facilities and earns the right to claim the associated renewable generation attributes, offsetting the environmental impacts of our operations. The RECs purchased under this agreement are from new renewable energy projects derived from wind resources installed after January 1, 1999. NREL's REC purchase is intended not only to offset electricity purchases from the grid, but also to provide replacement RECs for those RECs that the laboratory sells to fund its on-site renewable energy systems through power purchase agreements (PPAs) (see Greenhouse Gas Section).

The sale of RECs is financially advantageous for organizations, which can use the proceeds to reinvest in energy efficiency and renewable energy projects on-site as well as purchase RECs at a much lower cost that can be used to achieve carbon neutrality goals. Additionally these sales to Xcel Energy, our local utility provider, are used to meet the state of Colorado's Renewable Portfolio Standard requirements.

In FY 2012, the Federal Trade Commission (FTC) published Green Guides that advise those who sell RECs against making claims about hosting their renewable power systems, because such claims could mislead consumers. While the FTC Green Guides are not targeted at federal facilities, NREL is recommending adoption of this guidance in the interest of being transparent about our renewable system operations. By purchasing replacement RECs NREL can retain the renewable energy attributes associated with our renewable energy systems generation that offsets NREL campus electricity consumption.

BEST MANAGEMENT PRACTICES.....

Metering

NREL's electrical metering includes more than 200 advanced electric meters in all major facilities and on major process loads. To support DOE's metering requirements, NREL's design standard specifies that all new facilities include a main building electric

meter and electrical submeters that record heating, ventilation, and air conditioning (HVAC), laboratory process, and lighting loads. All NREL facilities that use natural gas have building gas meters. Energy Dashboard data system directly records 85% of natural gas use.

NREL's new data center, located in the LEED Platinum RSF, is independently metered and connected to the DOE Energy Dashboard system. Additional data center functions, housed in Building 17, are submetered for computer operations and cooling.

All of the facilities that require water on the STM site have dedicated utility water meters. There are also submeters for all make-up water systems for cooling towers, boilers, deionized water, and evaporative cooling sections in all facilities where applicable. The submeters are maintained and data recorded weekly by NREL in-house maintenance staff. All new facilities at the STM site will require a main building utility water meter, which will be supplied and installed by the water utility. NREL is moving towards sub-metering high-use water systems with new construction. As an NREL design standard for new and renovated spaces, water sub-meters are required at make-up water systems that support mechanical HVAC equipment and laboratory processes. An irrigation meter is also required for all newly constructed facilities, which use water on a short-term basis for plant establishment.

NREL's design standards require installation of BTU meters on chilled water and heated water systems for all new facilities that are tied into the main centralized heating and cooling plants. In 2012, NREL added additional chilled and heated water meters to the DOE Energy Dashboard system.

The NWTC metering upgrade plan focuses on NWTC metering infrastructure improvements including installing and replacing new power quality meters with less susceptibility to setting loss/errors and improved communication using TCP/IP rather than Modbus, alarm reporting, and remote meter resetting and calibration.

NREL developed a Tiered Approach to Meter Infrastructure to define criticality of data based on:

- Tier 1 (Critical) includes meters supporting DOE financial obligations such as Power Purchase Agreements (PPA's) and Net Metering for wind and PV. *Service Level Agreement (SLA) target: Data Quality: 98–100%/Data Availability: 99%–100%*
- Tier 2 (High) includes meters supporting main building meters or high priority meters—particularly if there are annual review/reporting requirements tied to the meters. *Service Level Agreement targets (to be determined)*
- Tier 3 (Low) includes meters supporting requirements not covered in Tier 1 or Tier 2 including submeters and low priority meters. *Service Level Agreement targets (to be determined).*

Expectations for these elements will provide more reliable and available metering data communications plus improved quality of data.

Integrated Project Teams

NREL utilizes integrated project teams (IPTs) in various development programs/projects for review and decision making. The emphasis and structure of the IPT is on the involvement of all stakeholders (users, technical experts, management, and contractors) in a collaborative forum. This gathering of a multi-disciplinary group has demonstrated effective project results by being involved in the early stages of development. Within Site Operations, IPT's are created with members from its facilities and sustainability group and researchers from the Science and Technology directorate to inform and collaborate on systems engineering methodologies and solutions for implementation. The team evaluates collectively to inform life-cycle decisions because the product or system development activities change and evolve over its life. For the development of our campus and building energy efficiency and renewable energy projects, NREL is at an advantage being a national leader in the clean energy industry. The group dynamic is extremely beneficial and enriching discussing is the real application of innovative technology. Education and knowledge sharing is key in nurturing, developing, and expanding NREL's core competencies.

The Building Agent and Campus Dashboard

The Building Agent (BA) aims to engage building occupants to building systems in a two-way conversation for optimized energy savings and comfort. To achieve this, the BA provides a cohesive set of tools and a framework linking building automation system (BAS) data, local environmental condition measurements, and occupant feedback to provide visualizations, empowering occupants and building engineers to take diagnostic, proactive, energy-saving, and comfort-improving actions. The BA system has four goals: (1) use occupant feedback to help commission and tune the building systems to optimize energy use and occupant comfort; (2) use occupant feedback and power monitoring to provide insight into control patterns of personal and public systems, as well as general occupant preferences; (3) test the effectiveness of various data visualizations for occupants and facility managers; and (4) lower energy use and demand by engaging occupants to influence behavior and empower the facility manager to make data-based decisions for diagnostics and optimization of systems.

The BA infrastructure consists of multiple layers: data and Web servers, sensor and building automation system (BAS) subsystems, and user application interfaces. An application interface on all computers collects comfort feedback and delivers notifications, such as guidance to open or close operable windows. A sensor layer provides local measurements of temperature, humidity, and lighting levels at individual workstations, and supplements data available from the Research Support Facility's lighting controls, BAS, and metering subsystems. All these data are collected, cleansed of erroneous values, and stored consistently in the server layer. The BA website is set up to present data in a range of visualizations for use by occupants and the facility manager.

The campus dashboard is one interface created using the BA infrastructure. This dashboard offers a high-level perspective of the energy use of buildings on campus as well as the current power consumption of each end-use building system (e.g., lighting, plug loads). The campus dashboard is an interactive display (also available via the BA website) that allows a user to look at high-level graphics then drill down to more detailed system information as needed.

The BA and dashboard infrastructure and initial deployments are complete. Work will continue in FY 2013 to refine the dashboard display functionality, add visualization options to the BA computer application, and engage occupants and building engineers in using the system in daily building operations.

Lighting

NREL follows a set of high-level best practices for lighting that has resulted in deep energy savings such as 75% versus an ASHRAE Standard 90.1-2004 baseline in the Research Support Facility. The best practices are:

- Reduce lighting power density (LPD)
- Layer daylighting control
- Layer occupancy control
- Layer task control (in addition to task ambient lighting)
- Define and follow a sequence of operations.

Example solutions that were born out of these best practices are using high-efficiency fixtures, high-efficacy sources, and a task/ambient layering scheme to reduce the office LPD from the code allowance of 1 W/ft² to 0.6 W/ft². The addition of daylighting, occupancy, and task control take the office operating LPD below 0.2 W/ft². Daylighting control is executed through a combination of switching and continuous dimming control via photocell. Occupancy control takes the form of scheduled overrides, or sweeps, in the open offices and occupancy sensors in closed spaces. Task control takes the form of security switches that allow for a low level of egress lighting to be switched on for ten minutes when needed for a security walk-through (instead of having security turn on all of the ambient lights at night). Additional solutions include the use of LED for exterior path lighting and parking garage lighting to achieve a low LPD. These lights are also on daylighting and occupancy sensors that allow the lights to be on only where and when they are needed by an occupant. In order to ensure that all of the control strategies driven by the best practices are designed, implemented, and commissioned to realize the expected energy savings, each project requires a written sequence of operations that outlines the equipment and expected operations in each space. A network connected lighting control system allows for ease of commissioning, and retro-commissioning as needed, to the sequence of operations.

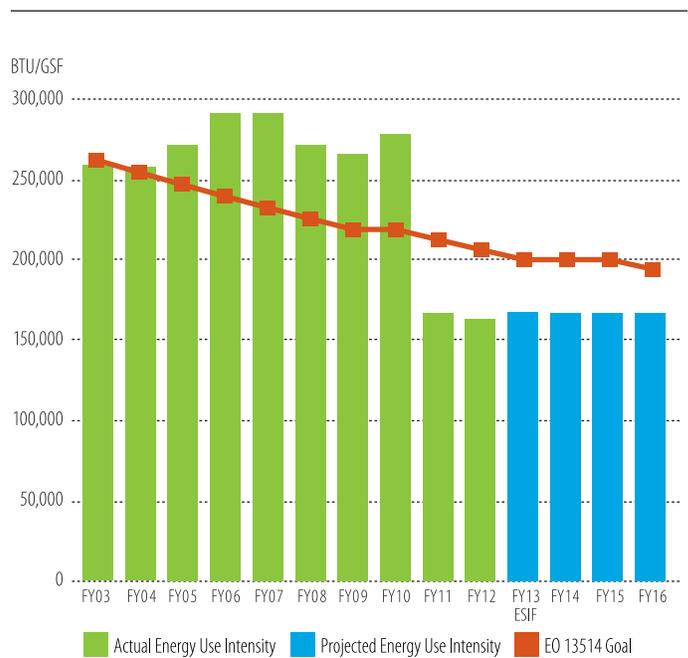
Budget and Funding

NREL takes advantage of its extensive on-site renewable energy systems to raise funds that are directed to campus energy efficiency and renewable energy projects. This is accomplished through two main mechanisms. NREL sells the RECs associated with its large PV arrays to our local power utility, which are used to meet the state of Colorado's Renewable Portfolio Standard requirements. Proceeds from these sales are redirected to high priority campus energy efficiency and renewable energy projects. An additional mechanism is offered by the power utility, where rebates are provided based on energy demand savings associated with new high-performance building design. These rebates are directed to energy efficiency improvement measures for the new building.

PROJECTED PERFORMANCE GOALS & STRATEGIES.....

Energy Intensity

NREL will meet and exceed DOE's energy intensity reduction goal by constructing new highly energy-efficient buildings, systematically implementing energy retrofits, and increasing on-site renewable energy generation. NREL will continue to optimize operations of the RFHP and will seek opportunities to purchase biogas to further reduce natural gas consumption. In addition, NREL has made commitments to purchase RECs to help reduce NREL's reportable energy intensity and subsequent GHG emissions. NREL will continue to purchase RECs to offset GHG emissions associated with campus electricity consumption.



NREL Actual & Projected Energy Use

The ESIF, planned for LEED Gold certification, is under construction and will open in FY 2013. This energy intensive 180,000 ft² laboratory building will increase NREL's electricity use by an estimated 45%, but has been designed to use energy as efficiently as possible. Heat rejected from the 1 petaflop (quadrillion Floating Point Operations per Second) High Performance Computer will be used to heat the building in cool weather; in summer the High Performance Computer will rely on cooling towers, yielding a low Power Usage Effectiveness (PUE) estimated to be 1.06 (see Water Section).

In addition to building loads, ESIF will have a high-performance data center projected to use at least a 1 MW constant load. Between these two loads, ESIF has the potential to effectively double NREL's electricity consumption. For reporting purposes, the data center is considered an exempted facility, which will not impact NREL's energy intensity. According to the Uptime Institute, the typical data center has an average PUE of 2.5. This means that for every 2.5 watts in at the utility meter, only one watt is delivered out to the Information Technology load. Uptime estimates most facilities could achieve 1.6 PUE using the most efficient equipment and best practices. While the new High Performance Computer will perform more computations for the same energy used, it will perform so many more flops that energy efficiency gains are offset by increased computations, resulting in increased power consumption. The first generation High Performance Computer is planned to be 1 petaflop and draw 1 MW, with an ultimate potential build-out of 10 MW. With these high demands in mind, NREL is taking every action to ensure that the data center operates as efficiently as possible. While a typical data center needs 100% to 200% of the electricity used in the High Performance Computer for external loads such as cooling and power conversion, ESIF will use less than 10% of computer energy for these purposes.

In FY 2013, the NWTC is adding a 5 MW dynamometer facility to test wind turbine drive trains. The dynamometer will run intermittently over the course of the year, with an estimated 5,600 MWh and \$350,000 in annual electricity demand.

EISA Audits

Energy Independence and Security Act of 2007 (EISA) audits were conducted for NREL's DOE-owned buildings in 2012. NREL intends to continue to perform all audits required to comply with the regulation by using in-house expertise to identify potential energy and water conservation measures. Prioritization of these measures will be determined based on a cost-benefit analysis. NREL will also continue to enter building data in the EPA Portfolio Manager tool. Sustainable NREL will also look into the feasibility of making campus operational changes to promote energy conservation.

NREL has identified a path forward to uphold compliance with EISA by identifying covered facilities that will be audited over the next four year cycle. NREL will conduct ASHRAE level two audits on all buildings using in-house expertise. As new LEED buildings are

PROPOSED SCHEDULE FOR EISA COMPLIANCE AUDIT	
Covered Facilities	Proposed EISA Audit Year
SERF, S&TF, FTLB	2012
OTF, TTF, IBRF (East), Shipping & Receiving	2013
NWTC Administration Building, STL, Dynamometer Spin Test Facility	2014

constructed they will be re-commissioned, bringing these facilities into EISA compliance. Once the next four year cycle of EISA audits is complete, NREL will have assessed over 80% of the site energy use. The proposed schedule for these audits is included in NREL's CEDR submission and is also summarized above.

Once a year's worth of operational data is available, RSF II will also be benchmarked in the Portfolio Manager tool. NREL will also begin benchmarking laboratory buildings in the Labs21 tool starting in FY 2013.

Energy Conservation Measures (ECMs)

As a result from the EISA audits conducted for SERF, S&TF, and FTLB, several ECMs were identified. Assessments for prioritized selection included scope of work, schedule, the value gained for improved building system performance, and fiscal feasibility considerations. Three projects to be implemented in FY 2013 include: S&TF Cool Recovery, S&TF Secondary chilled water pumps speed control, and SERF air compressor replacement.

Metering

Target for NWTC Tier 1 meter deployment is scheduled to be implemented by May 2013. The subcontract was recently awarded in October 2012.

In FY 2013 and beyond, NREL will work to enhance the Energy Dashboard system to provide additional analysis tools and reporting options. These enhanced capabilities will help to simplify direct monitoring of NREL's energy consumption and reporting for development of our Site Sustainability Plan (SSP), Pollution Prevention Tracking and Reporting System (PPTRS), CEDR, GHG inventory, and other DOE data requests. Enhanced energy enterprise management capabilities will also support the analysis of GHG reduction and energy efficiency opportunities, calculation of REC purchase quantities and return on investment for energy improvements, and provide educational support and outreach to help NREL uphold DOE's mission for energy efficiency and renewable energy. In addition, NREL is working to conserve and optimize water efficiency for campus irrigation by using a WeatherTRAK® smart irrigation system to automatically adjust landscape watering based on plant needs and daily local weather conditions.

Renewable Energy

Space for additional PV arrays will be allowed on any future buildings, including the ESIF and Cafeteria. These projects will exceed the Transformation Energy Action Management (TEAM) Initiative goal of acquiring at least 7.5% of each site's total annual electricity and thermal consumption from on-site renewable sources by FY 2010 and exceeds the EPACT 2005 goal of 7.5% for 2013 and beyond.

NREL also has an existing Western contract to purchase RECs for campus electricity use and USGBC LEED credit requirements (RSF 1 & 2, IBRF, Cafeteria, and ESIF). Through collaborative efforts with DOE and Western, an opportunity to procure energy from a new off-site wind farm project was discussed in September 2012. National Wind, LLC is in the process of submitting a proposal to NREL to provide 30 MW generation and green attributes (RECs) of wind-powered-energy for sale through a power purchase agreement on behalf of NECO Wind, LLC. A significant detail to be determined is the mechanism for the sale and delivery of power from NRECO to NREL that complies with Colorado statutes governing power procurement.

Budget and Funding

As opportunities for new on-site renewables and new high performance buildings arise, NREL will continue to utilize appropriate mechanisms that will help to finance additional projects on campus. NREL will continue to investigate new financial mechanisms in addition to REC sales and utility rebates to look for new opportunities to fund energy and water conservation projects.

To reduce deferred maintenance in particular, NREL Site Operations submits these priority projects for award within the Maintenance and Repair budget allowance. This small revenue source funds projects that can demonstrate replacement or enhancement for a system or component that reaches its end-of-service-life. All project criteria is identified in the Condition Assessment Information System (CAIS). Equipment flagged as deferred maintenance in CAIS is review by Maintenance and Engineering to determine priority of replacement.

MEASURABLE GOALS

In FY 2013, NREL will:

- Perform EISA audits of four additional covered facilities
- Benchmark RSF II in EPA Portfolio Manager
- Benchmark laboratories in Labs21 tool as applicable
- Continue retrofit T-12 fluorescent lamps
- Complete NWTCTier 1 meter deployment
- Continue Development of Campus Energy Dashboard
- Implement three Energy Conservation Measures (ECMs).



BUILDING, ESPC, REGIONAL AND LOCAL PLANNING

REGIONAL AND LOCAL PLANNING

An employee badges in at the SEB, joining scores of other NREL employees who opted to bike to work instead of driving.

GOALS

- **Regional Transportation Planning**
 - Completed construction of a new site entrance and enhanced roadway system
 - Participated in RTD and Jefferson County transit Comprehensive Master Plan and bicycle/pedestrian planning efforts
 - Provided shuttles connecting staff to RTD public transit services.

- **Environmental Management**
 - Initiated discussions with Jefferson County Planning and Zoning on proposed improvements to a drainage swale that NREL previously constructed on Jefferson County Open Space property to divert stormwater to the new STM stormwater detention basin
 - Incorporated identification and analysis of impacts from energy usage and alternative energy sources in NREL’s NEPA process
 - Continued work with the Jefferson County Nature Association and Jefferson County to manage noxious weeds.

STRATEGY AND PERFORMANCE SUMMARY

NREL coordinates with regional and local planning organizations and government agencies to improve land use, transportation, growth, and sustainability within the community.

NREL’s regional transportation and environmental management goals incorporate Executive Orders and expand Sustainable NREL initiatives. All campus projects 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.

FY 2012 PERFORMANCE STATUS.....

Regional Transportation Planning

All campus development is intended to create an environment that is pedestrian- and bicycle-friendly and accessible to public transit to reduce impacts of staff commuting. Moving labs and offices from leased space and consolidating them at newly constructed buildings on the STM Campus, is part of this development. Currently, NREL is not planning to construct new facilities outside of its existing campuses and is not pursuing new leases.

NREL continues to work with regional partners to improve the local land use decisions and transportation facilities that support alternative commuting options to NREL’s STM campus such as bicycling, walking, and using mass transportation. Specifically, NREL is actively involved with local governments and organizations to:

- Influence the enhancement and development of additional regional transportation infrastructure and services
- Promote and encourage efficient use of transportation, infrastructure, and services.

Through staff, NREL has direct contact with representatives from Jefferson County, City of Lakewood, City of Golden, and the Regional Transportation District (RTD). NREL works with these entities both on an informal, ongoing basis and formally at public meetings to engage with and influence transportation decision making:

- *Local Government Coordination.* NREL works with the City of Lakewood, City of Golden, and Jefferson County, Colorado to

make enhancements to adjacent roadways to improve conditions for transit patrons, and bicycle and pedestrian commuters.

- *RTD Coordination.* NREL works with RTD staff on an on-going basis to encourage and support enhancement of transit routes that serve NREL. Close cooperation with RTD is essential to building ridership.

NREL's activities for FY 2012 included:

- Continuing work with local jurisdictions to complete construction of a new south entrance with a roadway at Moss Street and South Golden Road. The new roadway provides an alternative access route to the campus alleviating traffic concerns at the main entrance on the east side of the STM campus. This infrastructure improvement addresses potential traffic impacts to adjacent intersections within the community from the recent growth of the laboratory.
- Working with the RTD by:
 - Hosting an open house for RTD staff to provide information on the opening of RTD's West Corridor Light Rail planned for April 2013, and soliciting feedback on related bus service. This will help to ensure that NREL is connected, to the extent feasible, with the new light rail line and that alternative commuting efforts are supported.
 - Working closely with RTD to coordinate and implement the deviation of an existing bus route from the established route and relocating the bus stop to better serve NREL via the new south entrance roadway. This enhances the public transit option for staff living in the Boulder area by decreasing the distance from the bus stop to NREL's STM campus.
- Working with Jefferson County staff to locate and install a bus shelter at a key RTD bus stop that was relocated to the new south entrance roadway. This provided a more comfortable and weather-protected waiting area for NREL public transit users.
- Continuing construction of on-site bicycle and pedestrian supportive infrastructure. This included sidewalks, bike lanes, bike racks, and storage lockers, etc.
- Coordinating and hosting events for regional rideshare and transit providers. These events enabled interaction between providers and NREL staff on regional alternative commuting support services. Providing input to Jefferson County's Comprehensive Master Plan update.
- Continuing to provide shuttle services that connect NREL staff with RTD public transit services enhancing mobility in the community by decreasing the amount of single occupant vehicle trips, especially during peak commuting hours.

NREL also continued its transportation program to help manage traffic, reduce GHG emissions and improve air quality. The program includes supporting alternative commuting options (ridesharing, bicycling, and transit use), flexible work practices, and telecommuting, which are described fully in the Greenhouse Gas Section.

NREL has also collaborated with and participates in DOE's Clean Cities Program. NREL provides technical and strategic support to the program, through publications, on-line tools and resources, and face-to-face meetings.

Environmental Management

Energy Coordination

NREL contributes to state and regional energy goals through deployment of renewable energy systems under contracting mechanisms such as PPAs. The state of Colorado has a 30% renewable energy portfolio requirement by 2020 for investor-owned utilities. Under this requirement, Xcel Energy purchases power and the environmental attributes from several of the NWTC wind turbines and NREL PV systems.

NREL is also working with the EPA and GSA Region 8 to negotiate the development of federal interagency off-site wind electricity from tribal sources. This is an ongoing effort that could play a large role in NREL's long-term goal to be a net-zero energy laboratory.

NEPA Guidance

NREL Environmental Assessments (EAs) and EA Supplements take into consideration routine on-site research and operational activities, including normal office work at the STM and NWTC. Additional environmental reviews are not required for these ongoing activities, as long as project scopes are constrained within the boundary analyses discussed in the EAs. An NREL National Environmental Policy Act (NEPA) review is required for projects requiring the expenditure of funds, such as subcontracts, cooperative research and development agreements, work for other agreements, and interagency agreements prior to contract award or initiation of activities. The subsequent NEPA determination will identify if the activity fits within earlier determinations in a site-wide EA or Supplement, if any categorical exclusion applies, or if a more rigorous environmental analysis is required, such as an EA or Supplement.

In FY 2012, NREL:

- Continued to include identification and analysis of impacts from energy usage and alternative energy sources in NEPA reviews. A site-wide EA Supplement for proposed facility expansion and infrastructure improvement was completed in November 2009 and generally addresses impacts from energy usage and alternative energy sources associated with this development.
- Completed an EA for proposed improvements to the RFHP. The proposed improvements include a silo for on-site storage of wood chip fuel to improve plant operational efficiency. This EA included identification and analysis of impacts from energy usage and alternative energy sources.
- Initiated sitewide EAs for both the STM and NWTC. Both of these EAs will include identification and analysis of impacts from energy usage and alternative energy sources. These EAs are planned to be completed in FY 2013.

NREL has a centralized site-planning process that ensures program facilities, activities, and any future site reconfiguration are analyzed in conjunction with the laboratory's EMS, which is an integral part of the Integrated Safety Management System (ISMS), and with NEPA; these programs are incorporated into project planning and work authorization processes. Such integration affords NREL the opportunity to continually improve environmental performance in accordance with the environmental sustainability goals of EO 13514.

Ecosystem Coordination

NREL has worked with Jefferson County extensively to support regional planning and environmental management. In particular, NREL has established conservation management areas at both the STM and NWTC to:

- Retain, preserve, and protect natural, scenic, ecological, and historical aspects of the property
- Protect the habitat for diverse vegetation, birds, and animals, i.e., enhance biodiversity.

In the development of its sites, NREL also uses native and adaptive plants, but not invasive plants wherever possible to promote regional identity and enhance wildlife habitat and biodiversity.

In 1999, NREL granted a 177-acre conservation easement on its STM site to Jefferson County to provide hiking trails and permanent conservation status for the STM site. According to NREL's Ten Year Site Plan, "no development can occur on this land, with the exception of existing utility easements; and Jefferson County Open Space has responsibility to establish and maintain formal trails on the conservation easement property."

Similar conservation management areas have been established at the NWTC to protect the site's natural resources (including wetland drainages, a wooded ridge area, ancient soils, and a remnant xeric tallgrass prairie area), and to prevent development within critical wind corridors. Over 60 acres have been set aside for this purpose. In addition to environmental commitments in the 2002 Sitewide EA to protect the site's unique natural resources, protocols are also included in NREL's Natural Resource Conservation Program and in a Memorandum of Understanding between the Trustee Council for Natural Resources at Rocky Flats and DOE's office of Energy Efficiency and Renewable Energy (EERE). In this agreement, the Trustee Council and EERE agree to consult and work together to preserve natural resources at the NWTC, and that EERE will manage and operate the NWTC consistent with NREL's Natural Resource Conservation Program. NREL is conscious of the impacts its site developments may have on local watersheds. As such, NREL has developed separate stormwater procedures for STM and NWTC addressing stormwater pollution prevention for construction activities. These procedures are included in construction specifications provided to construction contractors.

In FY 2012, NREL:

- Constructed the STM stormwater detention basin (Central Arroyo Detention Pond). This not only provides for surface water detention needs, but creates wildlife habitat and an open space amenity for the STM campus.
- Initiated discussions with Jefferson County Planning and Zoning on proposed improvements to a drainage swale. NREL previously constructed this drainage swale on Jefferson County Open Space property to divert stormwater to the new STM stormwater detention basin.
- Continued coordination with Jefferson County Open Space and Pleasant View Parks and Recreation District on revegetation efforts within off-campus areas. These areas were disturbed during construction of the STM stormwater detention basin and the new parking garage.
- Began early coordination efforts with the Federal Aviation Administration (FAA) on testing a new turbine and meteorological tower lighting system. The lighting system is intended to decrease avian attraction and, therefore, decrease avian fatalities associated with these structures.
- Worked with the Jefferson County Nature Association and Jefferson County to manage noxious weeds at both the STM campus and the NWTC campus.
- Worked within a multi-disciplinary team to design bird-safe glass features. Bird safe glass is intended for the new parking garage, retrofits of existing structures, and buildings such as the new Cafeteria.
- Installed CollidEscape®, an exterior vinyl film designed to minimize bird collisions with glass in NREL's glass bus shelters. Similarly, etched or patterned glass has been installed on the stairwells of the newly constructed parking garage to minimize bird collisions.
- Installed a wildlife-friendly boundary fence along the southern boundary of the STM campus which will facilitate animal movement from the Mesa Top through STM to Lena Gulch south of NREL. The laboratory continues to protect wildlife movement across the STM campus, while balancing the demands of an expanding campus infrastructure.
- Continued outreach efforts regarding the success of a study of vegetation plantings under PV arrays at the NWTC. Created a list-serve site for interested parties world-wide to share information on solar energy development and protection of natural resources.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.....

Regional Transportation Planning

In FY 2013, NREL will:

- Complete construction of the planned and designed additional turn lane on Denver West Parkway at Denver West Marriott Blvd. The new lane will increase traffic capacity at the main egress of the STM campus, and continue to mitigate potential traffic impacts associated with growth.
- Continue advocacy efforts for and construction of bicycle and pedestrian supportive infrastructure (sidewalks, crosswalks, bicycle lanes, bicycle racks, etc.) on the STM site and throughout the community.
- Continue to work with RTD as the new West Corridor Light Rail Line opens to ensure that NREL is served by the new route as much as possible.
- Continue NREL's shuttle program to connect staff with regional public transit services.
- Continue ongoing participation in local and regional transportation planning processes as appropriate.
- Continue working with local jurisdictions, RTD, and the Denver Regional Council of Governments RideArrangers program to advocate for, and support regional Transportation Demand Management strategies.

Environmental Management

Energy Coordination

NREL will continue to participate in discussions for a tribal wind purchase. NREL will also complete installation of the RSF complex PV systems for which RECs will be sold to Xcel Energy to meet their renewable portfolio standard. The sale of the RECs will be used for energy efficiency retrofit projects on NREL's campus.

NEPA Guidance

In FY 2013, NREL will continue to include consideration of energy usage and alternative energy sources, if applicable, in all future environmental impact statements and environmental assessments.

Ecosystem Coordination

In FY 2013, NREL will:

- Continue to work with Jefferson County to coordinate improvements to drainage infrastructure on the STM campus that discharge to Jefferson County Open Space property.
- Continue to coordinate with Jefferson County Open Space and Pleasant View Parks and Recreation on maintaining adjacent off-campus NREL revegetated areas that were disturbed during recent construction activities.
- Continue to collaborate with the FAA on future testing at the NWTC of a bird-friendly lighting system for large structures including wind turbines and meteorological towers.
- Better coordinate weed control efforts with adjacent land managers.

MEASUREABLE GOALS.....

In FY 2013, NREL will:

- Continue the shuttle program to connect staff with regional public transit services.
- Continue to strengthen relationships with regional planning partners by coordinating and hosting or attending events to support information exchange and improve regional transportation infrastructure systems and services.
- Continue to provide feedback to regional planning partners when solicited as part of regional planning processes.
- Continue to work within interdisciplinary groups to wildlife movement through our sites and to incorporate bird-safe design features wherever practical.
- Continue to work with Jefferson County to coordinate improvements to drainage infrastructure on the STM campus that discharge to Jefferson County Open Space property.
- Continue to coordinate with Jefferson County Open Space and Pleasant View Parks and Recreation on maintaining adjacent off-campus NREL revegetated areas that were disturbed during recent construction activities.
- Continue to collaborate with the FAA on future testing of bird-friendly lighting systems for aviation obstruction structures including wind turbines and meteorological towers.



FLEET

NREL has a growing alternative fuel infrastructure that includes natural gas (CNG), ethanol 85 (E85), and electric vehicle charging stations.

GOALS

- (3.1) Increase annual fleet alternative fuel consumption by 10% by FY 2015, relative to a FY 2005 baseline**
 - Alternative fuel use has grown 135% since 2005.
- (3.2) 2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline**
 - Petroleum fuel usage has grown 55.9% since 2005.
- (3.3) 100% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) by FY 2015 and thereafter (75% FY 2000-2015)**
 - No light duty vehicles were purchased in FY 2012.
- (3.4) Reduce fleet inventory of non-mission critical vehicles by 35% by FY 2013 relative to a FY 2005 baseline**
 - Vehicle reduction completed. To date NREL has disposed of eight vehicles. 100% of remaining fleet vehicles are mission critical.

STRATEGY AND PERFORMANCE SUMMARY

FY 2012 is the second year in a three-year fleet inventory reduction program required by the Secretary of Energy. While 100% of NREL's remaining fleet vehicles were deemed mission critical and no additional vehicle reductions are planned, annual efforts to reduce fleet and maximize fleet efficiency are ongoing in light of the lab's changing mission. NREL also continues to look for additional options to reduce impacts through AFVs as well as establishment of new policies and programs.

FY 2012 PERFORMANCE STATUS.....

Alternative Fuel Consumption

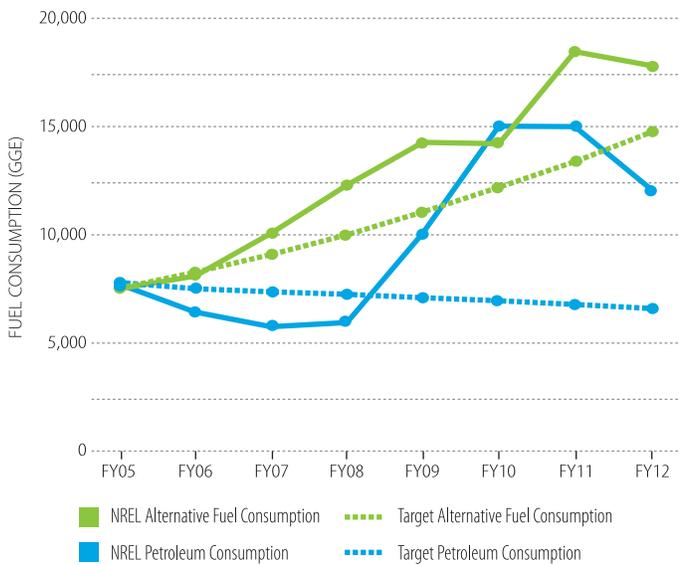
All NREL fuel data is reported in the Federal Automotive Statistical Tool (FAST) for each fiscal year. In FY 2012, NREL is exceeding federal requirements for alternative fuel consumption. NREL's alternative fuel use makes up 59% of NREL's fuel consumption in FY 2012 representing a 4% increase from last year. Since the base-line year of 2005, NREL's alternative fuel usage has grown 135%.

NREL has one on-site CNG fueling station. All E85 vehicles are fueled through private sector alternative fuel distributors when fuel is available.

A 1,800-space parking garage was constructed on the STM site in FY 2012 that includes 36 charging stations. At present, NREL does not have any electric or plug-in hybrid electric vehicles in the fleet. The charging stations will support future fleet electric and plug-in hybrid electric vehicles. NREL staff 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—being conducted on campus. However, priority use of the charging stations goes to NREL fleet vehicles.

Petroleum Reduction

In FY 2012, NREL's petroleum (gasoline and diesel) use made up 41% of fleet fuel consumption, decreasing 19% from last year. Overall, petroleum use is still 55.9% higher than the 2005 baseline but it is trending in the right direction. The decrease is due to an



NREL Fuel Consumption

overall reduction in the number of miles driven. In FY 2012, NREL logged 288,900 fleet miles, a 94,991 mile decrease in usage over the previous year.

In FY 2012, NREL rolled out enhanced video-conferencing capabilities including the installation of a video stream server in the RSF data center and a permanent large-scale video-conferencing system that can accommodate 60-plus people in one room that will ameliorate previous difficulties with streaming video conferences, reducing the need for ground travel.

In FY 2012, NREL also developed and distributed training materials on NREL's no-idling program and best practices to educate NREL fleet vehicle drivers and reduce the amount of fuel consumed with unnecessary idling.

There continues to be challenges with obtaining E85 fuel near the NWTC forcing drivers to use unleaded petroleum fuel. Also, there are currently no biodiesel retailers in NREL's vicinity.

Alternative Fuel Vehicle Purchases

NREL makes every effort to right-size its vehicle fleet, which currently consists of 42 vehicles including 40 GSA leased vehicles and two DOE-owned vehicles; 57% of the vehicle fleet is comprised of AFVs:

- 24 E85 vehicles
- 5 hybrid-gas vehicles
- 6 diesel vehicles
- 7 unleaded vehicles.

Fleet Reduction

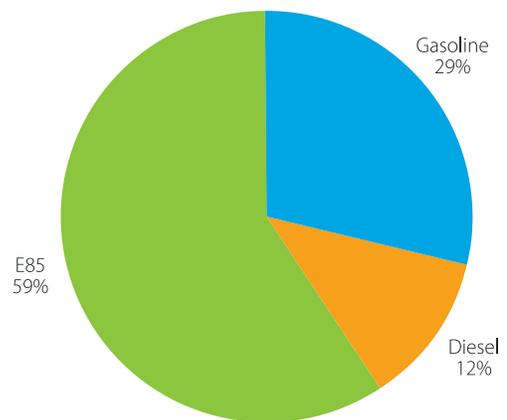
NREL continued the process to reduce the vehicle fleet in accordance with the Secretary of Energy's 35% fleet reduction requirement. In FY 2012, NREL disposed of one additional fleet vehicle bringing the total to eight vehicles or 17% of NREL total fleet. One hundred percent of remaining fleet vehicles meet criteria demonstrating the mission critical roles.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.....

Alternative Fuel Consumption

NREL's efforts to establish the most fuel-efficient vehicle fleet relies on continuous monitoring and recording of vehicle miles and fuel consumption and assessing vehicle usage. NREL is continuing efforts to increase overall fleet fuel economy by working with GSA to provide NREL with smaller sized, alternatively-fueled, or other advanced technology vehicles to improve the fleet efficiency.

NREL is also in the process of acquiring and installing an onsite E85 fueling station on the STM to further support increased use of alternative fuels. However, NREL will continue to fuel with alternative fuel (E85) as available through private sector alternative fuel distributors, as needed, which are located approximately five miles from the STM site. NREL also continues to work with DOE's Federal Energy Management Program (FEMP) and the local Clean Cities coalition to improve the fleet's ability to access and use alternative fuels, such as biodiesel.



NREL Fuel Consumption 2012

Petroleum Reduction

NREL is committed to reducing vehicle miles and petroleum usage through methods such as right sizing of the fleet, using shuttles, and video conferencing to reduce ground travel. When vehicle leases expire, NREL will look to replace vehicles that use petroleum with AFVs. Additionally, the E85 fueling tank that NREL is in the process of acquiring and installing will help decrease vehicle miles traveled to obtain alternative fuel offsite.

Alternative Fuel Vehicle Purchases

NREL's goal is to transform its fleet such that 100% of all non-exempt vehicles are AFVs. The laboratory will continue working with GSA and DOE to increase the number of AFVs in the fleet.

Due to the fleet reduction requirements, NREL has no plans for new purchases or leases in FY 2013. As existing vehicles age and become less fuel efficient or leases expire, NREL will look for opportunities to replace these vehicles with AFVs.

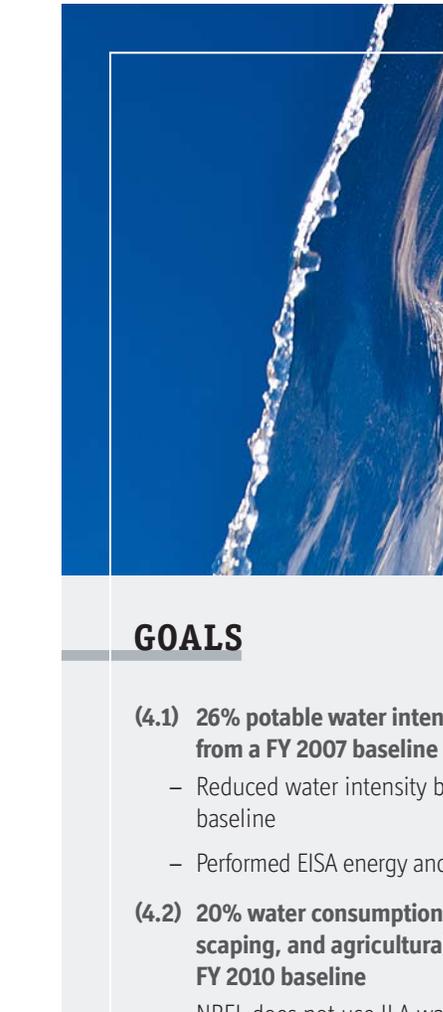
Fleet Reduction

One hundred percent of NREL's remaining fleet vehicles have been deemed mission critical and no further reductions are planned. Annually, NREL will reevaluate and investigate opportunities for right-sizing the vehicle fleet in accordance with mission changes.

MEASURABLE GOALS

In FY 2013, NREL will:

- Complete acquisition and installation of E85 fueling station on STM
- Continue to acquire GSA leased replacement vehicles that meet low emissions standards, if available
- Continue to acquire GSA leased replacements vehicles with AFVs, if available.



WATER

The RSF features a system where rainwater drains from the roof to recycled glass-filled drainage basins that filter the runoff before draining to a regional detention pond. By filtering runoff before discharging, NREL reduces its impact on local ecosystems.

GOALS

- (4.1) 26% potable water intensity reduction by FY 2020 from a FY 2007 baseline**
 - Reduced water intensity by 30% from the FY 2007 baseline
 - Performed EISA energy and water audits on three buildings.
- (4.2) 20% water consumption reduction of industrial, landscaping, and agricultural (ILA) water by FY 2020 from a FY 2010 baseline**
 - NREL does not use ILA water.

STRATEGY AND PERFORMANCE SUMMARY

NREL is committed to using water as efficiently as possible on campus. Given the location in the arid west, water is treated as a particularly precious resource. NREL implements all available measures to reduce potable water consumption. However, at this time state water law does not allow on-site collection and reuse of gray water sources and no municipal reuse water lines are in the vicinity of our campus. NREL will continue to explore opportunities as they become available to utilize non-potable water sources for the campus.

FY 2012 PERFORMANCE STATUS

Water Intensity

NREL's water consumption is reported in the CEDR to DOE. Water intensity values in the CEDR are developed using square footage for DOE-owned and leased spaces; however, NREL does not collect or report water data for leased buildings. The numbers in the table below have been updated this fiscal year to be consistent with the CEDR.

In FY 2012, water intensity was 21.1 gallons/ft² for indoor and outdoor use. Usage has increased 15% from 18.3 gallons/ft² in 2011. Water intensity in baseline year FY 2007 was 27.5 gallons/ft². Overall, potable water intensity has been reduced 30% between 2007 and 2012.

Indoor Potable water

In FY 2012, NREL's indoor potable water use was 15,126,200 gallons. NREL's indoor water intensity use was 16 gallons /ft². NREL has established best practices in design standards and operating procedures to promote the efficient use of potable water on campus. NREL's design standard calls for high efficiency, low flow, or flow flush fixtures in all new and existing buildings. To conserve water, NREL also limits once through cooling to devices that must operate at zero pressure and cannot be reconfigured to operate on building process cooling water. NREL's potable water usage on the STM campus is metered for each building. The NWTC has potable water trucked in to the site because there are no wells or potable water supply available. NREL has installed submeters on

NREL'S POTABLE WATER CONSUMPTION

	FY 2007 Baseline	FY 2011	FY 2012	Percent Change (from baseline, FY 2011)
Million gallons	13.2	13.2	19.97 (includes 4.78 for irrigation)	+51%, +51%
Gallons/ft ²	27.5	18.3	21.1	-30%, +15%

all high-intensity water devices including cooling towers, evaporative coolers, and autoclaves. Energy Independence and Security Act of 2007 (EISA) audits were performed on three of NREL's buildings in 2012: FTLB, SERF, and S&TF. Audits were performed using in-house expertise to evaluate mechanical, water, and plug load systems. Water audits considered the age and water efficiency of indoor fixtures such as faucets, toilets, urinals, showers, water heaters, and drinking fountains as well as outdoor water use for irrigation systems. Information from the water audits will be used to develop recommendations for future funding needs and building retrofit projects targeted at reducing campus potable water use.

Outdoor Potable water

Colorado rainwater harvest laws prohibit capturing stormwater for reuse. NREL does not have industrial, landscaping and agricultural (ILA) water sources. NREL's water utility provider 'Consolidated Mutual Water' can only deliver a potable water source.

NREL has developed new landscaped areas on its campus requiring irrigation until vegetation becomes established. NREL is working to conserve and optimize the water efficiency for campus irrigation by using a WeatherTRAK® smart irrigation system to automatically adjust landscape watering based on plant needs and daily local weather conditions. Irrigation systems use moisture sensors and only run when necessary. After plant materials become established, irrigation systems are taken offline and the areas planted in native species are adaptive to local climate conditions. NREL used 4.78 million gallons of water to irrigate these new areas in FY 2012.

- In FY 2013, the latest update to the water management plan will be completed. The 2010 and 2011 SSP's require sites to have an updated water management plan, as necessary to sufficiently address all the water use efficiency and management goals.

Stormwater

Section 438 of EISA and its associated guidance (required by EO 13514 and developed by the EPA) define the performance objectives to be used for preserving or restoring the hydrology of federal property. EISA 438 requires that for all federal facility construction projects that exceed 5,000 ft², the hydrology must be maintained or restored to predevelopment conditions, to the maximum extent technically feasible. The EPA guidance requires DOE facilities to determine the predevelopment hydrology of a site in one of two ways:

- Method 1 estimates runoff from the undeveloped site are calculated using the local 95th percentile 24-hour storm event as a basis (i.e. the storm event for which the depth of precipitation over a 24-hour period is greater than or equal to 95% of all of the 24-hour storms over a certain period of record, in this case, 30 years).

- Method 2 allows for calculation of the undeveloped site-specific hydrology through the use of several suggested hydrologic models, again using the 95th percentile 24-hour storm event as a basis.

The following activities at the STM and NWTC campuses were conducted in FY 2012 to conform to EISA 438 requirements:

STM Campus

Previously in FY 2011, NREL examined all STM drainage basins for compliance with EISA 438. The resultant modeling effort led to construction in FY 2012 of the Central Arroyo Detention Basin, which provides water quality and stormwater detention storage for both the 95th percentile 24-hour storm and the 100-year, 1-hour storm event (the latter being required by the local drainage district) within the STM campus middle drainageway basin. The basin was designed for detention rather than retention to comply with Colorado water law.

Construction of the basin was completed in August 2012. To date, the basin has received runoff from several low and high volume storm events and has successfully collected and filtered stormwater runoff prior to its release offsite and eventual discharge to Lena Gulch. This is accomplished through a combination of drop structures and forebays as well as planting installations that include native grasses, trees and bushes, as well as pre-vegetated mats. Improvement in stormwater water quality has been determined through collection of field turbidity measurements at all points entering the basin as well as at the discharge point. In addition to verification of overall improvement in stormwater discharge quality from the site, the water quality measurements have also enabled NREL to identify and resolve upstream sources of sediment to the basin.

New construction within the middle drainageway basin that now discharges runoff to the Central Arroyo Detention Basin includes the north wing addition to the RSF, a 1,800-car parking garage, a new Cafeteria, modifications to the existing 300-car surface parking lot, and completion of the ESIF. Extensive revegetation of areas disturbed during construction has also taken place in the middle drainageway basin. No significant development has occurred in either the east or west STM drainages during FY 2012.

Per EISA Section 438, low impact development (LID) practices continue to be incorporated into new construction and have included:

- *Porous pavements.* Porous paver materials were installed in the courtyards of the new RSF north wing, the hardscape areas surrounding portions of the ESIF, and the new parking garage.

Success Story

ZERO WATER GAS SCRUBBER

In January 2012, a gas scrubber that had operated continuously since 1993 was decommissioned. This scrubber used 2.5 gallons per minute around the clock. Over a year it consumed 1.3 million gallons, as much as 1/8 of NREL's annual water usage. In its life, this scrubber passed 22 million gallons of potable water through a 3/8 inch copper tube. Its replacement does not use any water.

NREL's monitoring activities evaluated two other existing systems, filterpave and pervious concrete which was installed in the STM surface lot in 2010. The filterpave system has performed very well. In late spring of 2012, a maintenance top coat was reapplied per the manufacturer's recommendation. Unfortunately the pervious concrete underperformed with large expanses decomposing. As part of the collaborative pervious pavement research and pilot project efforts, Urban Drainage and Flood Control District (UDFCD), who monitors these types of installation, visited late summer and agreed the product was an inferior performer.

- *Landscaping stabilization materials.* Pre-vegetated and slope stability mats were installed in the Central Arroyo Detention Basin. These materials are designed to improve slope stability during the restoration phase and to speed vegetation establishment.
- *Native prairie grasses, shrubs and trees.* Throughout the STM campus where small outdoor projects take place, NREL has planted native vegetation to prevent wind erosion and erosion and sedimentation from storm water/snowmelt on steep slopes.

NWTC

Development at the NWTC in FY 2012 consisted of a 5 MW addition to the existing dynamometer facility, a 25,000 ft² parking lot with associated walkways at Building 251, installation of several pole-mounted security cameras, and erection of three <1MW turbines. All sites were stabilized and re-seeded immediately following construction, with the exception of the dynamometer expansion project, which will be re-seeded in early FY 2013.

Industrial, Landscaping, Agricultural Water

NREL does not have any non-potable water usage on-site as this is not allowed by current Colorado water law.

Water Intensity Reduction

Potable Water

In FY 2013, ESIF will open. This 180,000 ft² building has cooling towers that will increase NREL water consumption by 30% or more. A more efficient technology, evaporative cooling, will be used in place of standard air conditioning for this building, eliminating electricity consumption at the expense of increased potable water use. NREL is implementing the most efficient cooling tower recirculation practices, with five cycles of optimal use before discharge. This is a best management practice for cooling tower operation. The resulting non-potable water contains high concentration mineral residuals that prevent its reuse on-site for irrigation purposes.

The NREL campus has several acres of newly-planted xeriscape. Irrigation is necessary to establish these plants in Denver's semi-arid climate. June, July, and August 2012 were each the hottest on record. Irrigation made up 25% of FY 2012 water consumption. By comparison, in the baseline year FY 2007, no water was used for irrigation. Once these planted areas are established, irrigation will be shut off.

In FY 2013, NREL will undertake an effort to perform additional EISA building audits on our campus. These audits will be used to identify energy and water savings opportunities within and around our buildings. Information from the FY 2012 water audits will also be used to develop recommendations for future funding needs and building retrofit projects targeted at reducing campus potable water use.

Stormwater

Preliminary design is currently underway for an expansion of the OTF building located in the STM west drainage. NREL will work with the designer to incorporate EISA requirements for detention and LID practices to the maximum extent practical despite the extremely limited site area and steep slope conditions. As additional small projects are identified, NREL will continue to incorporate LID practices to maximize stormwater runoff infiltration and evapotranspiration, and minimize landscaping irrigation in ways consistent with EISA 438 and local, state, and federal water quality and water rights regulations.

Project designers will continue to look for opportunities to incorporate LID practices in all NWTC projects. When additional DOE funding becomes available, the conceptual designs developed in the NWTC drainage study during FY 2011 will be advanced and constructed.

Water Management Plan

NREL's baseline 2003 Water Management Plan was updated in FY 2009. Since then, the campus has grown substantially with eight new high performance buildings, extensive site and landscape restoration, new roadways and the new High Performance Computer located in ESIF. A new Water Management Plan is

necessary to address the new water regime. In FY 2013, this revised plan will include updated strategies and actions to meet targets.

Unless ILA water becomes available in the campus vicinity, NREL has no plans to use ILA water.

MEASURABLE GOALS

In FY 2013, NREL will:

- Perform EISA energy and water audits of three additional DOE-owned facilities
- Develop recommendations for future funding needs and building retrofit projects targeted at reducing campus potable water use
- Monitor the performance of the Central Arroyo Detention Pond; the restoration of the native plant communities, sediment and debris removal, wildlife species utilizing this habitat, and promote the walking trail use for staff well-being.
- Collaborate with UDFCD to identify a new alternative to the pervious concrete paving mix prototype
- Investigate opportunities to incorporate LID practices on STM and NWTC campuses given the economic feasibility of 2013 project budgets
- Revise Water Management Plan with strategies and actions to meet targets.

Success Story | STORMWATER MANAGEMENT

Central Arroyo Detention Pond



Construction projects on South Table Mountain campus have significantly increased the amount of roof space and impervious land areas on the site. The Central Arroyo Detention Pond detains stormwater runoff from these areas, reduces peak flow events, and finally discharges downstream to Lena Gulch in a controlled manner. This constructed wet and dry meadow covers more than five acres and can detain more than 3 million gallons of stormwater. Two very unique construction materials were used to promote quick establishment of the constructed wet meadow and enhance water quality functions:

- *Forebays.* Runoff from upstream areas of the STM campus discharges and collects into three forebays. These areas function to reduce flow velocity, trap sediment and debris which is removed annually by a skid loader. Infiltration and pollutant uptake functions are enhanced because wetland plugs are planted in a continuous grid of pervious holes formed into the concrete.
- *Pre-vegetated Wetland Mats.* Twelve months prior to the installation of the pond, coconut coir mats were pre-planted with transitional wetland species to create an accelerated planting

product. This innovative filter material provides a broader surface area to diminish channel downcutting, forms a series of shallow basins to enhance infiltration, and its native plants biodegrade excess nutrients like nitrogen and phosphorous. The material is installed similar to laying out carpet disallowing areas of barren soil. This greatly lessens erosion and mitigates weed competition.

Complementary to this primary function of stormwater collection are other design considerations to create an aesthetic multi-purpose campus amenity:

- *Insects, Birds, and Mammals.* The surrounding vegetation community pond perimeter and patches provide an important local wildlife habitat. Nectar bearing forbs support pollinators such as bees, butterflies, and hummingbirds. Rodents and other small mammals provide food for local owls and raptors. Migratory songbirds use this habitat for breeding and or winter habitat. Other species frequently using this habitat include mule deer, coyote, and red fox.
- *Pond Perimeter Trail.* A one-third mile loop supports a pedestrian-oriented "Walking Campus" that encourages outdoor physical activity to improve the health and well-being for staff. Along the trail are benches to take in scenic views, observe wildlife, or relax. Interpretive signs identify features to educate the purpose and unique features of the pond.
- *Camp George West Firing Line.* The NREL Campus was previously used as Camp George West, a training installation established in the 19th Century for the Colorado National Guard. Remnants of a Camp George West firing line have been preserved and relocated in the upland area of the pond. This firing line was used for military rifle target practice until the end of World War II.



POLLUTION PREVENTION AND WASTE REDUCTION

To foster a culture of waste reduction, NREL promotes its 4Rs program (reduce, recycle, reuse, re-buy) on-site. Employees drop off books to be recycled at a recycling event sponsored by Sustainable NREL as part of Earth Week.

GOALS

- (5.1) Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris by FY 2015**
 - Diverted 81% of campus waste from landfill
 - Continued Pollution Prevention Initiative Program.
- (5.2) Divert at least 50% of construction and demolition materials and debris by FY 2015**
 - Diverted 88% of construction waste from landfill in FY 2012.

STRATEGY AND PERFORMANCE SUMMARY

NREL works toward near-zero waste by promoting sustainable decision making that considers product life from cradle to cradle. Making the 4Rs philosophy of reducing, reusing, recycling and rebuying integral to our operations, NREL balances environmental, social, and financial considerations.

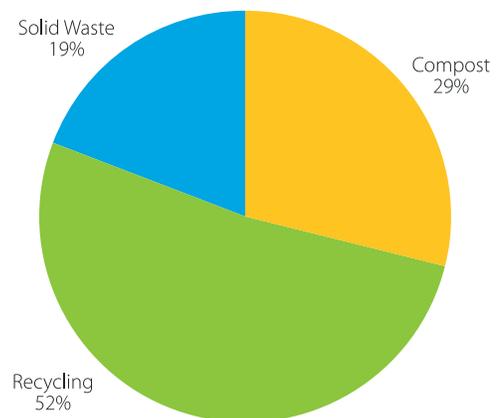
FY 2012 PERFORMANCE STATUS

Campus Waste

Waste Diversion

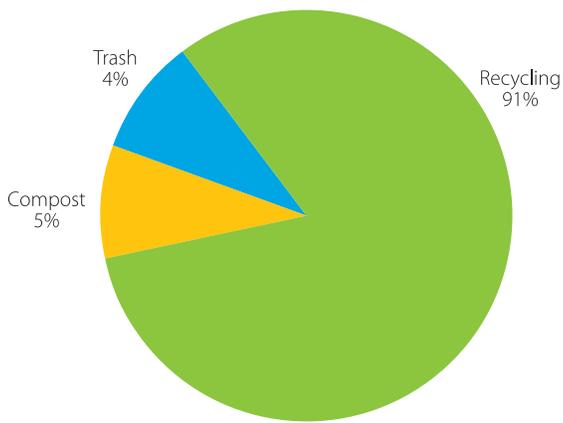
NREL diverted 81% of its campus waste from the local landfill. Waste diversion increased by 4% in FY 2012, just 1% short of NREL's self-imposed 5% goal. NREL's Near-Zero-Waste Initiative helped support this reduction by providing training on recycling and composting to employees.

New this year, NREL also included biomass waste from the IBRF and the new Cafeteria on the STM campus. The Cafeteria, which opened in June 2012, increased composting campus-wide by an additional 4% from the previous fiscal year.

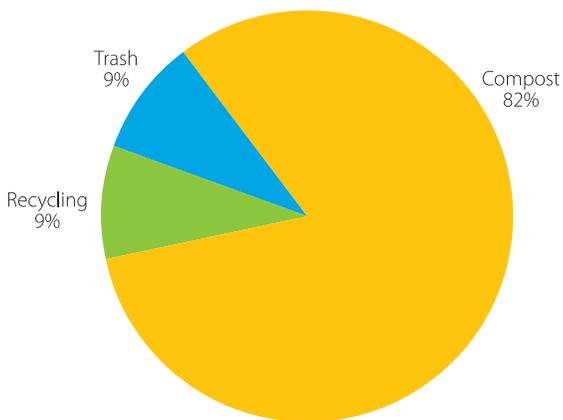


STM Campus Waste Diversion FY 2012

A waste audit was performed in RSF kitchens and break rooms with results indicating that the recycling and composting programs are successful. Overall, trash has been reduced and people are correctly separating and placing items into the appropriate trash, recycling, and compost bins. On average, only 9% of the recycling collections were contaminated with trash or compostable materials and 18% of the compost collections were contaminated with either recyclables or trash. The trash audit showed a higher contamination rate with approximately 49% compostable or recyclable materials found in the trash. All FY 2012 solid waste, recycling, and compost data were submitted in the PPTRS (see charts below).



STM Campus Unsorted Recycling FY 2012



STM Campus Unsorted Compost FY 2012

Opportunities for Staff to Bring Recycling Items from Home

NREL organizes the following events for staff members biannually:

- Electronics recycling to dispose of hard-to-recycle personal items such as computers, printers, and monitors
- Document shredding and recycling to dispose of sensitive personal documents in a safe environmentally friendly manner.
- A Used Book, CD, and DVD Drive, which benefits a deserving school or other nonprofit organization in the community. Fifty percent of the proceeds from items sold go to a school. Those items that cannot be sold are redistributed to a literacy-focused non-profit organization, including libraries and schools. Those items that cannot be sold or redistributed are recycled. This event was so popular that a permanent bin has been installed near the parking garage for employees to recycle their used books, CD and DVDs.

In FY 2011, NREL joined the EPA Federal Green Challenge and WasteWise Programs to participate in federal waste prevention and resource conservation. NREL continues to replace computer printers, copiers, scanners, and fax machines with ENERGY STAR-certified multifunction devices (MFD) on campus—effectively reducing the need for standalone equipment. Only MFDs are allowed in all new facilities. Defaults on all computers and printers are set for double-sided printing. In FY 2012, NREL reduced paper usage by 35% exceeding its self-imposed goal of 5%. Although NREL's population has grown, these measures have reduced paper usage from 4.9 reams per person in FY 2011 to 3.1 reams per person in FY 2012. All paper used at NREL contains at least 30% post-consumer fiber. As a new introduction to promote paper manufactured from responsible renewable resources, NREL made copy paper available from sugar cane. This Cane Fields product is made from 80% sugar cane waste, or "bagasse", and 20% Certified Plantation Fiber instead of trees from forests. All cartridges from the MFDs are sent back to the manufacturer or a subcontractor to be recycled or reused.

Pollution Prevention

Sustainable NREL and the EHS Office continued the Pollution Prevention Initiative Program (PPI)—providing NREL staff with the opportunity to submit their ideas on the reduction of waste, materials, water, air emissions, and energy use. The project ideas submitted by staff are being evaluated for feasibility and further consideration.

In FY 2012, two pollution prevention assessments were initiated and implementation will continue into FY 2013:

- Promote the use of the NREL Office Supply Depot—a location where staff currently drop off unwanted office supplies for others to reuse. This helps NREL save money and helps the environment by reducing purchases of new office supplies and reducing the amount of materials that would otherwise end up in a landfill.

Success Story

FEDERAL ELECTRONICS CHALLENGE

For the second year in a row, NREL's Federal Electronics Challenge Team has earned the Federal Electronics Challenge (FEC) Platinum-level Award, which recognized their actions to help the federal government improve its sustainable practices. In the previous year, NREL raised the bar and was the only DOE facility to receive the Platinum-level; this year, NREL is one of three.

NREL achieved the Platinum-level award by completing many projects, including implementing several Basic Ordering Agreements to help manage energy-efficient computing equipment requirements and costs. In fact, 99% of desktop computing devices purchased at NREL comply with Electronic Product Environmental Assessment Tool (EPEAT) and ENERGY STAR requirements. Other projects included creating a database to track lifecycle data for electronic equipment, ensuring the environmentally friendly disposal of electronics, and reviewing and revising NREL's policies to make our information technology environment even more energy efficient.

In addition to these activities, NREL also drafted a case study documenting NREL's electronics life-cycle management and sustainability practices. The study documents the decline in NREL's overall power consumption at the desktop level by about 78%.

- Evaluate the lab's waste diversion to determine if key waste streams, such as wood and metals, are consistently being diverted from the landfill.

Chemicals

NREL relies on several systems to reduce the quantity of toxic and hazardous chemicals and materials acquired, used, or disposed of including a Chemical Management System and Excess Chemical Inventory. NREL conducts annual training on chemical safety and hazardous waste management for all lab workers and a formal hazard identification and control process is used to minimize the risks associated with any new or changed lab process. Annual goals for pollution prevention are set as part of NREL's Environmental Management System (EMS). NREL also works toward DOE's goal to use alternative chemicals and processes by giving preference to environmentally preferable products, including bio-based products, Electronic Product Environmental Assessment Tool (EPEAT) electronics, and low- or no-volatile organic compound (VOC) paints.

In FY 2012, several of NREL's laboratories were remodeled. During this process, the EHS Office encouraged researchers to scrutinize chemical inventories for excess hazardous materials that could be removed from use or identified as surplus for use in other labs. NREL also continued to track refrigerants and fluorinated compounds purchased, and maintained a chemical inventory using its Chemical Management System. Regular reviews of Safe Operating Procedures and Readiness Verifications (for new activities or activities with changing scope of work) were also conducted to include consideration of potential GHG impacts from chemical purchase, use, storage and disposal.

Pest and Landscape Management

When control of pest wildlife species is necessary, an integrated approach is used to humanely eradicate pests and minimize other potential impacts. Building design features and administrative controls are the first line of defense against pests. When these are not fully effective, additional controls are used. Native pests are relocated whenever possible. When pests must be destroyed, mechanical methods are preferred over poisoning. When necessary, pesticides are selected to target specific pests to avoid non-target animal poisonings. Pesticides are typically only used indoors or immediately surrounding buildings. Animal poisons are discouraged for use outdoors.

NREL uses an integrated weed management approach that incorporates various types of weed control methods including herbicide treatment, mechanical practices (e.g., mowing), biological (e.g., organism specific to weed species eradication), cultural practices (e.g., reclamation of disturbed areas), and prevention (e.g., limiting or eliminating driving of vehicles off established roadways). The effectiveness of control methods is periodically assessed. The use of

multiple strategies for control and specific use and timing of herbicides has been successful in significantly reducing populations of diffuse knapweed and Canada thistle. The weed control program maintains the flexibility needed to respond to changes in weed populations from year to year. Periodic mapping of weed infestation areas assists in targeting weed control efforts. NREL also uses a certified-weed free, native grass seed mix for re-seeding of disturbed areas.

NREL's Weed Management Program was updated in FY 2012 and includes the latest strategies and best practices incorporating Integrated Pest Management philosophy. NREL worked in cooperation with the Jefferson County weed control coordinator and surrounding landowners to improve the management of listed noxious weeds at its sites. NREL treated 30 acres of grasslands at its STM campus to control Canada thistle, Scotch thistle, myrtle spurge, and diffuse knapweed and 64 acres at its NWTC campus to control knapweed and Canada thistle, all state-listed noxious weeds. Improved management will result in enhanced wildlife habitat. The Weed Management Program is scheduled for revision on a five-year basis.

In FY 2012, NREL continued its participation in the Sustainable "SITES" Initiative Pilot Program, an interdisciplinary partnership led by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center, and the United States Botanic Garden, working to foster a transformation in land development and management practices. The benefit of participation in this program is an opportunity for the project to utilize the guidelines presented to create performance benchmarks for sustainable land design, construction and maintenance practices. Through the submission process, all credit requirements are evaluated for certification.

NREL's pilot project boundary includes the Research Support Facility, the Central Arroyo Detention Pond, the middle drainageway, and portions of the STM conservation area.

Property Clearance and Release

Current NREL procedures call for mitigation of any materials with radiological contamination prior to release. NREL procedure 6-3.2, Laboratory and Equipment Decommissioning, was reviewed and reissued in 2009. If any contaminated equipment is planned for removal from the site, radiation levels must be mitigated to background levels prior to removal.

Construction Waste

In FY 2012, NREL's campus footprint grew approximately 750,420 square feet. As a responsible measure of this expansion, NREL was able to achieve an 80% diversion of construction waste through comprehensive recycling programs. With the incorporation of the

Success Story

NREL REDUCED CO₂ EMISSIONS

Switching Its Tracer Gas to Nitrous Oxide for Fume Hood Commissioning

After an FY 2011 assessment and further investigation in FY 2012, it was determined that nitrous oxide (N₂O) produces far fewer greenhouse gas emissions than sulfur hexafluoride (SF₆). NREL modified its contract with its fume hood testing contractor to require that N₂O be used as the tracer gas for all ASHRAE 110 tests.

NREL achieved a reduction of roughly 337,580 pounds of equivalent CO₂ emissions annually by switching to N₂O, a tracer gas used for fume hood commissioning, from SF₆, which is now specifically banned from NREL campuses. Fume hood commissioning is conducted to verify that new or relocated fume hoods meet state requirements. A test meeting the requirements of the ASHRAE 110 standard must be conducted before fume hoods are commissioned. NREL typically conducts five to ten ASHRAE 110 fume hood tests annually.

SF₆ is the most potent of the six commonly accepted greenhouse gases, with a global warming potential (GWP) 23,900 times that of carbon dioxide (CO₂) when compared over a 100-year period. Sulfur hexafluoride is also extremely long-lived, is inert in the troposphere and stratosphere, and has an estimated atmospheric lifetime of 800–3,200 years.

Nitrous oxide (N₂O) has been proven as a successful alternative tracer gas for testing fume hoods to the ASHRAE 110 standard. With a GWP of 310, N₂O produces far fewer greenhouse gas emissions than SF₆. Conducting an ASHRAE 110 test using N₂O results in roughly 33,758 pounds less of CO₂ equivalent emissions per test due to its significantly lower GWP-77 times less CO₂ emissions than if SF₆ is used.

new language in the Subcontractor Statements of Work (SOW) in FY 2011, subcontractors must track the quantity of waste generated and recycled for campus projects. Subcontractors performing on-site construction projects are also encouraged to participate in the campus composting program. This process refinement facilitated new green specifications for existing buildings projects.

Developed by Sustainable NREL in FY 2012, the specifications are consistent with the LEED Existing Buildings: Operations and Maintenance (LEED EB-O&M) rating system and support aggressive waste diversion goals of at least 70% by volume.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.....

Campus Waste

Waste Diversion

Waste diversion efforts will continue and additional measures will be investigated and considered in FY 2013 by Sustainable NREL's Near-Zero Waste Committee to determine the best means for achieving additional waste reductions.

Pollution Prevention

In FY 2013, NREL will continue implementing two pollution prevention assessments initiated in FY 2012 in topic areas that will help the lab uphold DOE's pollution prevention goals.

Chemicals

In FY 2013, NREL will continue to maintain its chemical inventory system at a high level of accuracy and broad functionality for all users. Training programs will continue to promote the use of materials with lower toxicity wherever possible and emphasize the availability of the excess chemical inventory. With the addition of a major new research facility, the Energy Systems Integration Facility (ESIF), new technologies for chemical tracking are being evaluated for better management of chemical inventories. A detailed evaluation of the chemical life cycle at NREL is planned for FY 2013 to better understand the laboratory's investment in inventory maintenance and chemical waste management.

Pest and Landscape Management

In FY 2013, a Landscape Maintenance Plan will be developed as part of the Sustainable SITES program, which will provide guidance on proper landscaping maintenance and materials in support of:

- Plant stewardship
- Invasive species management
- Organic materials management
- Soil stewardship
- Irrigation and water use
- Stormwater management and best management practices (BMPs)
- Materials management

- Recyclable materials
- Landscape maintenance equipment
- Snow and ice management.

Property Clearance and Release

NREL procedure 6-3.2, Laboratory and Equipment Decommissioning will be reviewed and revised as needed in FY 2014.

Construction Waste

Sustainable NREL will continue to track data and enforce subcontractor SOW requirements for all construction projects in FY 2013.

MEASUREABLE GOALS

In FY 2013, NREL will:

- Complete two pollution prevention assessments initiated in FY 2012
- Perform detailed evaluation of chemical life cycle at NREL
- Task the Near-Zero Waste Committee with identifying and implementing projects to increase waste diversion as part of NREL's participation in EPA programs
- Continue on-site waste audits to analyze waste stream and identify opportunities for additional reduction
- Complete participation in Sustainable SITES program and conduct three monitoring programs for rehabilitation of the middle drainageway and wetlands, invasive weed management, and restoration of native plant communities
- Create a Landscape Maintenance Plan
- Investigate soy-based printer toner cartridges.



SUSTAINABLE ACQUISITION

NREL aggressively promotes the acquisition of sustainable products. Shown here are office supplies made from recycled materials from NREL's sustainable office supplier.

GOALS

(6.1) Procurements meet requirements by including necessary provisions and clauses (Sustainable Procurements/Biobased Procurements)

- New P-Card sustainable purchasing requirements
- Enhanced green office-supply subcontract requirements.

STRATEGY AND PERFORMANCE SUMMARY

NREL continues to work to implement new policies and programs that increase the acquisition of sustainable products and engage in contracts consistent with EO 13514. NREL's prime contract with DOE requires that the lab's procurement practices be consistent with all federal green procurement preference programs, which include the purchase of:

- Electronics and computing equipment that are EPEAT registered, ENERGY STAR or FEMP-designated
- Products manufactured from recovered materials
- Environmentally preferable products (EPP)
- ENERGY STAR energy-efficient products
- Biobased products
- Non-ozone depleting substances.

In FY 2011 and 2012, NREL constructed several new LEED buildings, established a campus-wide green cleaning janitorial contract, and created sustainable acquisition policies and procedures. Key to transforming acquisition practices is the modification of staff and subcontractor behavior and providing incentives for participation. To support this, NREL educates staff and subcontractors about sustainable product alternatives.

FY 2012 PERFORMANCE STATUS

Sustainable acquisitions data were submitted for FY 2012 in the PPTRS. In 2012, 88% of construction contracts included sustainable acquisition requirements.

In FY 2012, NREL purchased over 99% of its desktop computing devices as EPEAT-compliant. Because of NREL's purchasing policy and staff participation in adhering to recommended equipment when purchasing, 97.8% of the lab's computing equipment purchased in FY 2012 is EPEAT gold certified, 1.8% is silver certified, and only 0.4% does not align with FEC standards. NREL maintains a database of vendor sustainability practices to track vendors not governed by EPEAT standards. Only those vendors whose manufacturing, distribution, and operations practices meet or exceed EPEAT standards are selected for business with the lab.

In FY 2012, Policy 10-1: General Procurement was finalized and included a sustainable acquisition section. PCard and purchase request procedures were also finalized and implemented in FY 2012, requiring consideration of a sustainable product before purchasing. Performance associated with these new policies and procedures are monitored through NREL business systems, contractor tracking reports, and basic ordering agreements. The business systems are being updated to capture sustainable acquisitions.

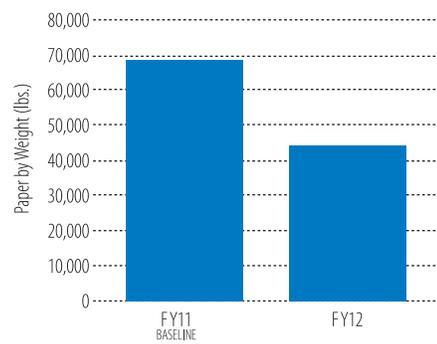
In FY 2012, NREL purchased more than \$300,000 in green supplies, including toner cartridges and copy/prINTER paper from the CADDO office supply catalogue and GSA. PCard purchases included: recycle, compost and waste bins made with 35% recycled content; laboratory supplies; and signage. The CADDO catalogue, which includes earth-friendly office supply products, manufactured from recycled content facilitates green purchases for staff.

In FY 2012, NREL worked with its CADDO office-supply subcontractor to increase the availability of green office-supplies. New products included:

- Pens from recycled water bottles
- Ergonomic chairs made from 97% recycled materials
- Paper made from sugarcane rather than trees
- Pen refills (to reduce the amount of plastic sent to recycling).

NREL also collaborated with CADDO to host a series of meetings to provide information to staff about green office-supply products and preferred purchasing procedures.

- At the beginning of the calendar year, a green office-supply fair was held introducing NREL employees to new green office-supplies.
- At NREL's annual Earth Week fair, CADDO showcased their green office-supplies.



Paper Reduction Goal

In FY 2012, NREL participated in the EPA's Federal Green Challenge, which is a national initiative for federal agencies to lead by example in reducing the federal government's environmental impact through sustainable materials management. As part of NREL's participation in this program, NREL pledged to increase EPP for campus activities by 5% in FY 2012 from a FY 2011 baseline. In order to meet the Federal Green Challenge goal, NREL identified the following targets for FY 2012:

- *Reduce usage of office paper by 5%.* We successfully reduced our paper usage by 24,365 pounds or 35% from the FY 2011 baseline.
- *Green Cleaning Plan.* With the green janitorial contract in place, 100% of cleaning products used by janitorial staff were biobased and 100% of paper products used were made of recycled-content materials.
- *Meeting and Event Services.* Meetings, trainings, and conferences at NREL were generally catered by small local food service businesses (85%) offering only "Green" catering. In June 2012 an on-site Café opened providing catering services for all NREL meetings and events. Depending on the event, use of reusable dishware, silverware and glassware or compostable plates, cups and utensils is required. The Café also provides reusable dishware, silverware, and glassware and compostable takeout containers, plates, cups and utensils.

PROJECTED PERFORMANCE GOALS AND STRATEGIES.....

In FY 2013, NREL will continue to promote employee awareness of the availability of green products and encourage use of these products for daily office functions. This effort will include enhancing green product information provided to administrative staff that performs the primary ordering of office supplies.

MEASURABLE GOALS.....

In FY 2013, Sustainable NREL will:

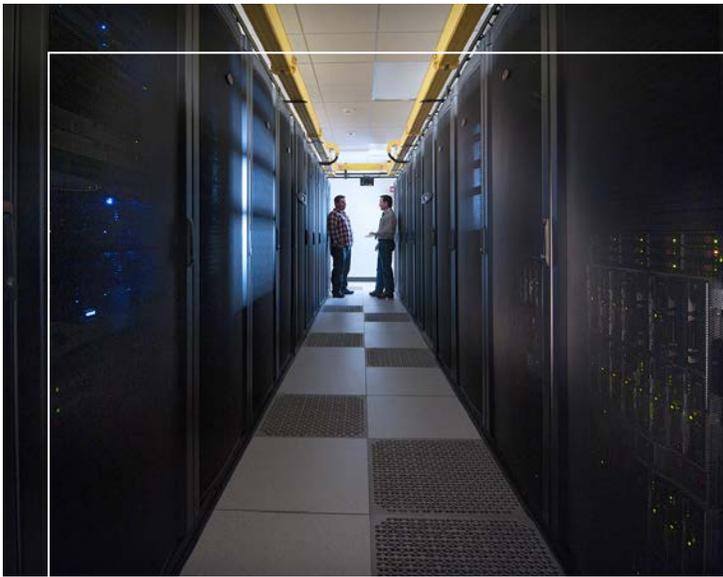
- Continue to do waste audits and identify opportunities for further reductions
- Complete the business systems reporting update to accurately reflect sustainable acquisitions
- Roll out mandatory annual training for new and existing PCard users/approvers.

Success Story

GREENBUY PROGRAM GOLD WINNER

NREL achieved excellence in Sustainable Acquisitions and Green Purchasing, attaining the Leadership Goal for 17 Priority Products in five different categories. These categories include:

- Compostable materials from Cafeteria, Green Bean and Golden Grounds
- Construction materials
- Office materials: paper, electronic toner cartridges, etc.
- Grounds/landscaping: use of native plants requiring less water
- Operations: data obtained for the FY 2011 PPTRS.



DATA CENTERS AND ELECTRONIC STEWARDSHIP

NREL's world-class data center is located in the RSF.

GOALS

- (7.1) All data centers are metered to measure a monthly Power Usage Effectiveness (PUE) (100% by FY 2015)**
 - NREL's RSF data center meters data center lighting, auxiliary plug loads, backup generator fuel heater, air handler unit, and chilled water to calculate monthly PUE.
- (7.2) Maximum annual weighted average PUE of 1.4 by FY 2015**
 - In the past 12 months, the PUE for the RSF data center has averaged 1.13.
- (7.3) Electronic Stewardship – 100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY 2012**
 - Power management is enabled on 100% of eligible devices.

STRATEGY AND PERFORMANCE SUMMARY

NREL continues to focus its efforts on electronic stewardship, including utilizing the most energy efficient ways of doing business at the laboratory. By utilizing cloud computing, virtual desktops, and monitoring performance across the campus, NREL shows improvement in optimizing its Information Technology (IT) services. The past several years have brought dramatic changes and improvements with electronic stewardship and data center operations. FY 2012 proved to be a year of exceptional performance with a focus on maintaining efficiency.

The lab continues to publish case studies, participate in the Federal Electronics Challenge (FEC), act as a mentor organization, and contribute to industry presentations. NREL is a resource and shares energy efficiency best practices both internally and with external organizations.

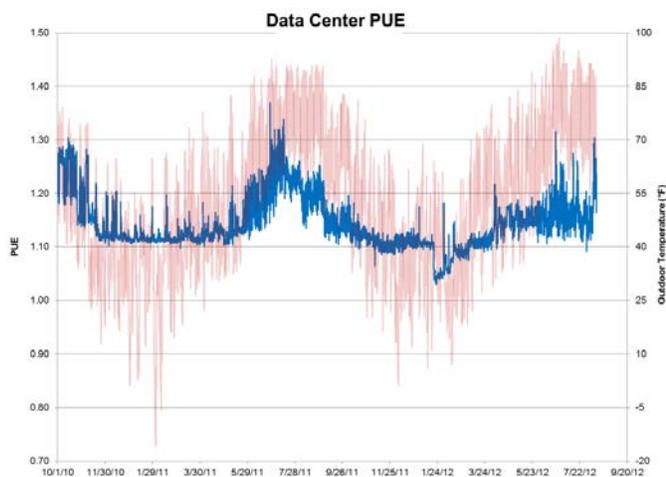
FY 2012 PERFORMANCE STATUS

Data Centers and Electronic Stewardship

Data Center Operations

The primary data center for NREL's campuses is located in the LEED Platinum RSF. NREL's RSF data center meters data center lighting, auxiliary plug loads, backup generator fuel heater, air handler unit, and chilled water to monitor its world class PUE. The data center's meter is connected to the DOE Energy Dashboard system. NREL uses the DC Pro tool to provide energy assessment and energy profiling data for the RSF data center. In FY 2013, the legacy data center, housed in Denver West Building 17, which is used to support a few remaining IT functions is planned to be decommissioned.

In FY 2012, NREL modified the data center's air delivery system, replacing the air diffusers with air registers. This seemingly small switch allows air to be delivered more efficiently, helping to support our world-class PUE. The data center was also modeled for hot and cold airflow, allowing the air to be delivered where it is needed.



Power Management

NREL is continuously monitoring power usage and plug loads at the desktop level. In FY 2012, NREL implemented an application to monitor, audit, and report on desktop power management settings. The lab is also piloting thin client systems to reduce desktop and laptop use and enable power management on all administrative desktops.

Purchasing and Disposition Practices

NREL continues to provide purchasing guidelines and recommended equipment for all end-user computing equipment, printing devices, and network technology infrastructure to promote energy efficiency while maintaining operational quality.

NREL's hardware standards ensure that only the most highly-rated energy-efficient computers, monitors, and peripherals are purchased and used across the lab. This equipment meets ENERGY STAR 4.0 and EPEAT standards. NREL purchases predominantly LED-backlit LCD monitors and has an ongoing project to replace all remaining fluorescent-backlit LCD and CRT monitors with more energy efficient alternatives. Exceptions are made on a case-by-case basis when approved through NREL's internal exception request process.

NREL has moved from inefficient desktop computers toward highly-efficient laptop computers, and only purchases monitors with energy-saving features. Desktop printers and standalone fax machines are purchased only when needed, and are otherwise replaced by multifunction devices that copy, print, scan and fax. In FY 2012, more than 99% of purchased desktop computing devices were EPEAT-compliant. Because of NREL's purchasing policy and staff participation in adhering to recommended equipment when purchasing, 97.8% of the lab's computing equipment purchased in FY 2012 is EPEAT gold certified, 1.8% is silver certified, and only 0.4% does not align with EPEAT standards. NREL maintains a database of vendor sustainability practices to track vendors not governed by EPEAT standards. Only those vendors whose manufacturing, distribution, and operations practices meet or exceed EPEAT standards are selected for business with the lab.

Each year, NREL participates in the FEC to ensure that the lab meets and exceeds the electronic equipment requirements of EO 13514 for the full-cycle management of computers, laptops, monitors, printers, fax machines, and television set purchases. For the second year in a row, NREL was honored with the Platinum-level FEC Award, which recognizes the lab's actions to help the federal government improve its sustainable practices.

Other projects included creating a database to track lifecycle data for electronic equipment, ensuring the environmentally friendly disposal of electronics, and reviewing and revising NREL's policies to make our information technology environment even more energy efficient. NREL utilizes Metech, an environmentally-sound electronics recycler, to dispose of all equipment that is not donated or resold at the end of its useful life.

In addition to these activities, NREL also produced a case study documenting NREL's electronics life-cycle management and sustainability practices. The study documents the decline in NREL's overall power consumption at the desktop level by about 78%.

PROJECTED PERFORMANCE GOALS AND STRATEGIES

Data Centers and Electronic Stewardship

NREL continues to incorporate sustainability and leadership by example in its strategic plan, including identifying, evaluating, and embracing cloud-based solutions.

The past several years have included huge shifts from outdated systems that were huge energy consumers to a focus on efficient computing equipment and education of staff on green IT practices. FY 2013 will allow NREL to focus on maintaining its sustainable practices and mentoring other organizations on green data centers and electronic stewardship.

Data Center Operations

NREL will continue to optimize data center PUE operations and performance. The RSF data center success story will be used as a mentoring opportunity for other DOE agencies and organizations seeking to improve the sustainability of their operations. Lessons learned from the implementation of the RSF data center will be used during the build out of the ESIF data center.

Purchasing and Disposition Practices

NREL will continue its commitment to purchasing electronic equipment that is approved by the FEC and will continue to update its purchasing guidelines to reflect improvements in equipment energy efficiency. NREL will also focus on mentoring activities to assist other federal facilities with meeting the requirements of EO 13514 and to maintain FEC Platinum level partnership.



Success Story | DATA CENTER

How do you take one of the most energy efficient data centers and make it more efficient? At NREL, a proof-of-concept test by the Data Center Manager led the Site Operations staff and Commercial Buildings researchers to get together to brainstorm seemingly small fixes that could lower the energy use even more.

After modeling the data center for air flow in FY 2012, adjustments were planned to more efficiently distribute supply air. The original air conditioning outlets were located on top of the data center racks and provided poor distribution of air throughout the data center. A new adjustable supply air diffuser now delivers air to the front of rack and delivers more air to the areas in the data center with the greatest heat load. By sealing ceiling plenum leaks and optimizing evaporate cooling and fan control, energy use in the data center is further minimized.

These efforts improved the power usage effectiveness from 1.15 in 2011 to 1.147 in 2012—helping NREL minimize energy use, while optimizing the performance of our world class data center.

Power Management

Staff in the Commercial Buildings group at NREL are working to deploy a plug load monitoring and control tool on individual workstations. Staff will be able to see in real time what their plug loads are and can work to lower their plug loads. The tool will connect the building and the occupants, and will optimize occupant comfort and energy use, by engaging the occupant with the building.

MEASUREABLE GOALS

In FY 2013, NREL will:

- Continue to maintain Platinum-level FEC designation
- Meet or exceed world-class PUE (less than 1.3).

INNOVATION AND GOVERNMENT SUPPORT

David Danielson, Assistant Secretary for DOE Office of Energy Efficiency and Renewable Energy, and his staff take a tour of the ESIF under construction.



GOALS

(8.0) Innovation and Government-Wide support: Site-specific objectives

- Enhanced behavior agent program and conducted RSF I comfort survey
- Entered into discussions for 30 MW offsite wind farm (Power Purchase Agreement)
- Continued outreach for knowledge sharing with other federal agencies (NASA, DOE, GSA, and City of Lakewood)
- Advanced energy efficiency and governmental support showcasing the RSF to over 40K visitors per year and providing workshops to commercial industry and other government agencies.

INNOVATIONS.....

Described in previous chapters, NREL's innovations in FY 2012 were numerous including three on-site renewable energy systems and the construction of four new high-performance sustainable buildings (see Executive Summary: Successes and Challenges, and High Performance Sustainable Buildings: Net-Zero Buildings).

ESIF

NREL's biggest innovation in FY 2013 is the Energy Systems Integration Facility (ESIF). Nearly four years in the making, the ESIF is highly energy efficient and is one of the only megawatt-scale test facilities in the United States that integrates electricity, thermal, and fuel systems with high performance modeling and simulation capabilities (see High Performance Sustainable Buildings Section). These capabilities are critical to safely moving clean-energy technologies onto the electrical grid at the speed and scale required to meet national goals.

Research Focus

As new technologies are integrated into the energy system infrastructure, the pathways between production and end use are becoming more complex and interrelationships are forming between electrical, thermal, and fuel systems.

At NREL, energy system integration research focuses on design and performance of energy systems that are optimized at different, but interrelated scales, ranging from individual homes and businesses to communities and cities to regional and national infrastructures, and can be aggregated to optimize energy pathways at any scale.

By considering the relationships among transportation and fuel production systems, the built environment, electricity generation systems, and integrated energy systems, we can accelerate an energy system transformation.

Success Story | INTERGOVERNMENTAL GROUP WORKS TO ACHIEVE ENERGY AND SUSTAINABILITY GOALS

An intergovernmental sustainability group continues to work on energy and sustainability goals long after the success of a six-month Sustainability Challenge campaign held in FY 2011. Challenge participants included: NREL, DOE Golden Field Office, the Rocky Mountain Region General Services Administration, Environmental Protection Agency Region 8, and the City of Lakewood.

The goals of this six-month campaign were to promote conservation awareness, save natural resources, and reduce greenhouse gas emissions. The Challenge engaged employees from all organizations in events such as:

- Waste and recycling presentations
- Nature hikes led by NREL biologists
- National Academy of Sciences presentations on climate change
- Composting and water conservation classes
- Electronics recycling
- Tours of a hydrogen bus
- The U.S. Geological Survey Ice core lab at the Federal Center
- Tours of NREL's net zero-energy Research Support Facility.

The Challenge's success set the stage for continued collaboration on mutual sustainability goals. Meeting on a regular basis, this intergovernmental group has investigated:

- Potentially sharing shuttle operation costs around a soon-to-be completed new light rail system
- Community recycling operations
- Providing technical support to conduct a volunteer energy audit of city of Lakewood's Graham House, while mentoring students from a local college on auditing techniques.

These collaborative projects demonstrate the benefit of Federal agencies leading by example and working with neighbors and stakeholders, including state and local government entities, area businesses, and non-profit organizations, to help achieve a goal or target under EO 13514. These intergovernmental projects are being nominated for the White House Council on Environmental Quality (CEQ) GreenGov Community Spotlight.

A Unique Partnering Facility

With the collaboration of industry partners and NREL's more than 30 years of experience, the ESIF will help overcome technical barriers to effectively and reliably operate energy systems with high levels of renewable energy. Integration research will include, but is not limited to:

- Building and facility systems
- Community power generation and microgrids
- Utility generation
- Grids that incorporate renewable energy (solar, wind, hydrogen, advanced vehicles), energy efficiency technologies, electricity system architectures, and grid interoperability.

This partnering facility will provide industry partners the opportunity to work with NREL and insert their individual technologies into a controlled integrated energy system platform to test and optimize the technologies to reduce the risk of early market penetration.

Labs and Equipment

To support these areas of research, the 185,000 ft² ESIF will house approximately 200 scientists and engineers, more than 14 fully equipped laboratories. In addition, the ESIF will include other key service and support features, such as:

- Research Electrical Distribution Bus (REDB)
- High Performance Computing Data Center (HPCDC)
- Hardware-in-the-loop
- Prototyping at megawatt-scale power
- Collaboration and visualization rooms
- High Bay control room.

ESIF Snapshot

- Cost: \$135M
- Square feet: 130,000
- Occupants: 225
- Super computer: teraflop-scale; planned to be expanded to petaflop-scale
- State-of-the-art electric systems simulation and visualization in an HPC environment
- Component and systems testing and validation at MW-scale powers
- Integration of functioning systems with utility system simulations for real-time, real-power evaluation of high penetration scenarios
- Construction completed: December 2013

More information is available on NREL's ESIF webpage:

www.nrel.gov/esi/esif.html

GOVERNMENT SUPPORT/OUTREACH

Solar, Hydrogen and Lithium Ion Fuel Cell Car Races

In May 2012, the Junior Solar Sprint, Hydrogen Fuel Cell, and Lithium Ion Battery car competitions were sponsored by the U.S. Department of Energy's Office of Science, U.S. Department of Energy's Golden Field Office, Jefferson County Public Schools, Dakota Ridge High School, Rocky Mountain Bottled Water, the Alliance for Sustainable Energy, and NREL.

One hundred four teams from 23 Colorado schools participated in the car competitions. The student teams raced solar, lithium ion, or hydrogen fuel cell powered vehicles they designed and built themselves.



Cherry Creek High School's team celebrates their victory. From left: Coach Steve Lohman, Atul Tiwary, Patrick McMullen, Rajeev Vishwamitra, Ross Dodson, and Tae Kim.

Success Story | SCIENCE BOWL

For more than 20 years, NREL and DOE have been actively encouraging high school students to expand their knowledge of math and science through the Colorado Science Bowl.

In April 2012, Denver, Colorado's Cherry Creek High school won the competition after competing with 27 other high schools in Washington, D.C. The competitors were required to answer questions involving physics, math, astronomy, chemistry, anthropology and earth sciences.



CLIMATE CHANGE ADAPTATION

Climate change may pose a wide range of impacts including increased frequency and intensity of drought or storm events.

GOALS

- **Improve Understanding of Climate Change Effects and Impacts**
 - Work with other agencies to improve our understanding of climate change.
 - Work with other federal agencies and local jurisdictions (as appropriate) to develop regional partnerships for climate change information sharing and collaboration.
- **Improve Understanding of Climate Change Vulnerabilities and Risk**
 - Conduct detailed risk or vulnerability assessments, as appropriate, for specific DOE programs or facilities.
- **Improve the Climate Resiliency of all DOE Sites**
 - Update all appropriate DOE site plans to address climate change resiliency.
 - Identify or establish and participate in regional climate change adaptation partnerships, as appropriate, for all DOE facilities.

STRATEGY AND PERFORMANCE SUMMARY

Mitigating climate change is fundamental to NREL's mission of researching and deploying renewable energy and energy efficiency technologies. By advancing low carbon energy alternatives, NREL is playing a leading role with international climate and clean energy initiatives to achieve large greenhouse (GHG) reductions.

CLIMATE CHANGE EFFECTS AND IMPACTS

Climate Technology Initiative

NREL has been a partner with the Climate Technology Initiative (CTI)¹ since its founding and has provided assistance in technology needs assessments, technology program design, and expert exchange.

The Climate Technology Initiative:

- Supports clean energy technology transfer efforts under the United Nations Framework Convention on Climate Change (UNFCCC)
- Advances market-friendly approaches to accelerating the deployment of technologies that reduce greenhouse gas emissions
- Advances effective adaptation strategies to mitigate climate change.

Integrated Environmental Strategies Program

NREL provides technical support for the Integrated Environmental Strategies (IES)² program. Initiated by the Environmental Protection Agency, the IES program promotes integrated planning to address local environmental concerns and also reduce associated GHG emissions. The program encourages developing countries to analyze and implement policy, technology, and infrastructure measures with multiple public health, economic, and environ-

1. Climate Technology Initiative. Accessed November 29, 2012: www.climatetech.net/about/.

2. Integrated Environmental Strategies. Accessed November 29, 2012: en.openei.org/wiki/EPA-Integrated_Environmental_Strategies.

mental benefits. Government agencies and research institutions in Argentina, Brazil, Chile, China, India, Mexico, the Philippines, and South Korea have participated in the IES program.

Intergovernmental Panel on Climate Change

NREL is working with the Intergovernmental Panel on Climate Change (IPCC)³ on the scoping for the Special Report on Renewable Energies. In addition, NREL has formed a partnership with the Integrated Assessment Modeling Collaborative for research to improve the representation of renewable energy resources and technologies in integrated assessment models. Those models will provide key analysis and scenario input to the IPCC's Fifth Assessment Report.

Low Emission Development Strategies

NREL is preparing a methodology and toolkit to assist developing countries with the preparation and implementation of low-carbon clean energy growth plans.

U.S. OpenLabs Program

In partnership with the U.S. Agency for International Development and DOE, NREL and other DOE labs have established U.S. OpenLabs⁴ a multi-laboratory expert team that is assisting developing countries on clean energy and climate issues.

Open Energy Information (OpenEI)

NREL has established the OpenEI portal⁵ for DOE to serve as a global community platform for information on clean energy technologies, analysis, policies, and resources.

CLIMATE CHANGE VULNERABILITY, RISK RESILIENCY

NREL has been participating in the DOE Climate Change Adaptation Planning Working Group since 2011. In this effort NREL has participated in regular working group calls and reviewed DOE's "Draft Climate Adaptation Plan" for submission to the Council on Environmental Quality (CEQ)⁶ and the Office of Management and Budget (OMB)⁷. NREL has also provided knowledge and input in the development of DOE's "High Level Analysis of Vulnerability to Climate Change" published in April 2012.

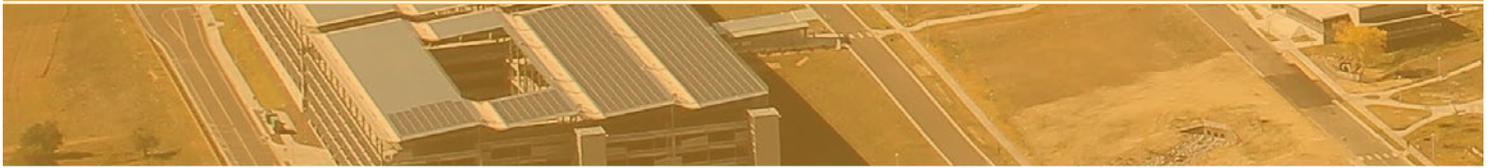
NREL actively seeks educational opportunities to improve the understanding of climate change risk and resiliency measures. NREL participates in regional collaborations to promote sustainability and will explore these vehicles to further adaptation planning efforts. As appropriate, pertinent information will be incorporated into site development plans.

3. Intergovernmental Panel on Climate Change. Accessed November 29, 2012: www.ipcc.ch/.
4. U.S. OpenLabs. Accessed November 29, 2012: en.openei.org/wiki/gateway:u.s._openlabs/about.
5. OpenEI portal. Accessed November 29, 2012: en.openei.org/wiki/main_page.
6. Council of Environmental Quality. Accessed November 29, 2012: www.whitehouse.gov/administration/eop/ceq/.
7. Office of Management and Budget. Accessed November 29, 2012: www.whitehouse.gov/omb/.

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National Renewable Energy Laboratory
15013 Denver West Parkway, Golden CO 80401
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