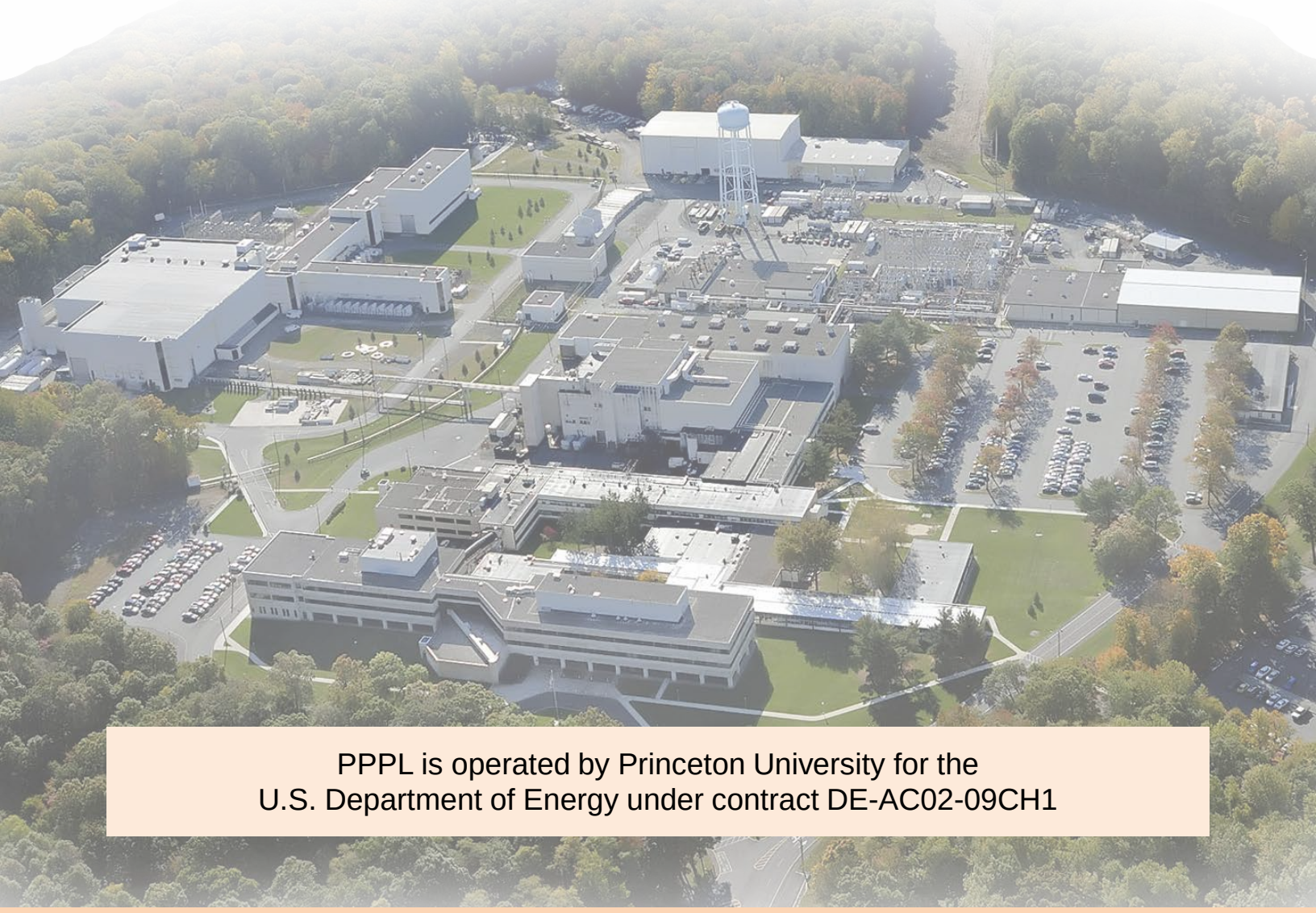
Princeton Plasma Physics Laboratory

DOE ORDER 436.1

SITE SUSTAINABILITY PLAN

Fiscal Year 2015



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List of Acronyms

AFVs – Alternative Fuel Vehicles

ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers

B20/B100 – Biofuel 20 %/100%

BAS – Building Automation System

Btu/sf – British thermal units per square foot

C&D - construction and demolition (materials and debris)

CAC - Computer air conditioning

CD-0 – Critical Decision Zero

CEDR – Comprehensive Energy Data Report

CFC - chlorofluorocarbons

CFL – Computers for Learning

CNG - compressed natural gas

CRAC - Computer Room Air Conditioning

DESC – Defense Energy Support Center

D&R – Delaware & Raritan (Canal)

E85 – Ethanol 85 %

ECMs – Energy Conservation Measures

EADS – Energy Asset Disposal System

EPDM - ethylene propylene diene monomer

EEB - Energy Efficient Buildings

EISA07 – Energy Independence and Security Act of 2007

EMS – Environmental Management System

EMS4 – DOE's Energy Management System v. 4

EO13423 – Executive Order 13143, *Strengthening Federal Environmental, Energy and Transportation Management*

EO13514 – Executive Order 13514, *Federal Leadership in Environmental, Energy and Economic Performance*

EPACT05 – Energy Policy Act of 2005

EPEAT – Electronic Product Environmental Assessment Tool

ERLE – energy related laboratory equipment

ESD – Environmental Services Division

ESH&S – Environment, Safety, Health and Security (Department)

ESPC– Energy Savings Performance Contract

EUI – Energy Utilization Intensity

FAST -Federal Automotive Statistical Tool

FEDS – Federal Disposal System

FEWG – Fugitive Emissions Working Group (DOE)

FIMS – DOE's Facilities Information Management Systems

GHG – Greenhouse Gas

GPP – General Plant Projects

GSA -General Services Administration

HEMSF – High Energy Mission Specific Facility

HPSB – High Performance Sustainable Buildings

HVAC – Heating, Ventilation and Air Conditioning

HVST – High Voltage Switch Tube

IH – Industrial Hygienist

ILA – Industrial, Landscaping, & Agricultural

IOI – Infrastructure and Operations Improvement project

IPM – Integrated pest management

ISO-14001 – International Organization for Standards, Standard 14001, *Environmental Management Systems – Requirements with guidance for use*

IT - Information technology

KBtu/gsf – kilo British thermal unit per gross square feet

kW(hr) – kilowatt (per hour)

LEED – Leadership in Energy and Environmental Design

LTSP - Linux Terminal Server Project

LSB – Lyman Spitzer Building

MSW – Municipal Solid Waste

MWh/yr – Megawatt hour per year

M/R - Modulator/ Regulator

mtCO2e – Metric tons carbon dioxide equivalent

NBI -Neutral Beam Injection

NSTX –National Spherical Torus Experiment

NSTX-U – National Spherical Torus Experiment Upgrade

O436.1 – DOE Order 436.1, *Departmental Sustainability*

OPEX – Operating funds expenditure project

ORNL – Oak Ridge National Laboratory

PPA – purchase power agreement

PFC -Princeton Forrestal Center

PPLCC - PPPL main computer center area

PPTRS – DOE's Pollution Prevention Tracking and Reporting Systems

PUE – Power Utilization Efficiency

RF - Radio Frequency

RFP - request for proposal

ROI - return-on-investment

SDS – Safety Data Sheet(s)

sf – square feet

SF_6 – Sulfur Hexafluoride

SLI – Science Laboratory Infrastructure project

SR - solar reflectance

SSPP – DOE Strategic Sustainability Performance Plan

TE - Thermal Emittance

T&D – Transmission & Distribution

UESC – Utility Energy Service Contract

USDA - US Department of Agriculture

USGBC – United States Green Building Council

VFD - variable frequency drive

1. Executive Summary

The Princeton Plasma Physics Laboratory (PPPL) conducts world-leading collaborative scientific research into plasma physics to develop and demonstrate the practical application of fusion power as a sustainable global alternative energy source. This research mission enables the fundamental technology discoveries that advances DOE's energy, national security and sustainability mission. Fusion energy research experiments are by nature high-energy intensive devices – designed to replicate deep space and stellar conditions. Development of magnetic fusion energy as a viable global energy source could dramatically change the course of fossil fuel use and global climate change by providing a globally available environmentally attractive carbon-neutral energy alternative. PPPL is located on Princeton University's James Forrestal Campus in Plainsboro Township, Middlesex County, New Jersey, and has operated at the current site since 1958.

PPPL has institutionalized a comprehensive approach to fulfilling the requirements of Executive Orders 13423 and 13514, as well as applicable DOE Orders, to advance the DOE energy, national security and sustainability missions. The DOE sustainability goals are fully integrated into PPPL's ISO-14001 certified Environmental Management System (EMS) as our EMS objectives and targets. PPPL reduced its Scope 1 and 2 Greenhouse Gas (GHG) emissions by 79.8% in FY2014 compared to the FY2008 baseline. This significant reduction in GHG emissions is largely due to the focused efforts to control fugitive losses of sulfur hexafluoride (SF_6) and reduced emissions from on-site combustion of fuel through boiler plant improvements and energy efficiency projects. Our electricity use is down 31.8% from the baseline year, partially due to lack of NSTX experimental operations during the upgrade project. We have also cut fleet GHG emissions by 56.6% since FY2008 through careful fleet management and the use of cleaner burning alternative fuels like E85 (85% ethanol) and B20 (20% biodiesel). Scope 3 GHG emissions were down 9.1% in FY2014 compared to the FY2008 baseline.

PPPL's efforts to reduce the waste generated from Laboratory operations yielded recycling rates for solid waste and construction waste of 77.9% and 84.1% respectively. PPPL continues efforts to facilitate the purchase of environmentally preferable products through lab-wide subcontracts and by enhancing sustainable acquisition guidance and resources available to employees. Large scale on-site renewable energy and high performance building improvements are severely limited under current Laboratory funding profiles.

Table 1 provides a summary of FY2014 performance and planned actions to attain the DOE sustainability goals. The performance status for each goal is color coded: blue for exceeded the goal, green for met/meeting the goal, yellow for not met but on target and red for at risk. Figure 1 provides a graphical summary of GHG emission reductions from FY2008 to FY2014 showing dramatic reductions in the Laboratory's GHG footprint over the past four years. Figure 2 presents a summary of projected GHG emissions based on the management approach outlined in this plan.

Table 1 - DOE Goal Summary Table

SSPP Goal #	DOE Goal	Performance Status through FY 2014	Planned Actions & Contribution	Risk of Non-attainment
Goal 1: Greenhouse Gas Reduction				
1.1	28% Scope 1 & 2 GHG reduction by FY 2020 from a FY 2008 baseline (2014 target: 19%)	**EXCEEDED** Scope 1&2 GHG emissions down by 79.8%	Continue to focus on energy efficiency, especially electricity use.	NA
1.2	13% Scope 3 GHG reduction by FY 2020 from a FY 2008 baseline (2014 target: 5%)	**ON TARGET** Scope 3 GHG emissions down by 9.1%	Continue to emphasize energy efficiency, business travel and employee commuting	Moderate. Ongoing international research emphasis
Goal 2: Sustainable Buildings				
2.1	30% energy intensity (Btu per gross square foot) reduction by FY 2015 from a FY 2003 baseline (2014 target: 27%)	**EXCEEDED** 39.3% reduction from 2003 baseline	Continue to focus on energy efficiency and building energy performance	Low. Limited funding available for ECMs
2.2	EISA Section 432 energy and water evaluations	**MET**	25% of buildings were evaluated in 2014	NA
2.3	Individual buildings metering for 90% of electricity (by October 1, 2012); for 90% of steam, natural gas, and chilled water (by October 1, 2015) (2014 target: 90% and 75%, respectively)	**MET**	Additional sub-metering as cost-effective and programmatically appropriate	NA
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.	**MET** 17% of building footprint has cool roofs	R-30 is standard for roof installation and replacement	NA
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 (2014 target: 13%)	**ON TARGET** LSB is LEED-Gold and met Guiding Principles. Other buildings in progress	Four additional buildings are currently being assessed against the Guiding Principles.	Moderate. Limited funding available for ECMs
2.6	All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the GPs.	**ON TARGET**	Future new construction & major renovations will comply with Guiding Principles	Moderate. Subject to constrained funding
2.7	Efforts to increase regional and local planning coordination and involvement	**ON TARGET** PPPL site development is governed by the Princeton Forrestal Center Master Plan, which addresses local planning issues.		

SSPP Goal #	DOE Goal	Performance Status through FY 2014	Planned Actions & Contribution	Risk of Non-attainment
Goal 3: Fleet Management				
3.1	10% annual increase in fleet alternative fuel consumption by FY 2015 relative to a FY 2005 baseline (2014 target: 136% cumulative since 2005)	**EXCEEDED** 70% of total fleet fuel used in 2014 was alternative fuel	Fleet management initiative has impacted alternative fuel use	NA
3.2	2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline (2014 target: 18% cumulative since 2005)	**EXCEEDED**	Continue to manage fleet to optimize alternative fuel use and support program needs	NA
3.3	100% of light duty vehicle purchases must consist of alternative fuel vehicles (AFV) by FY 2015 and thereafter (75% FY 2000 – 2015)	**MET**	Continue acquiring AFVs as appropriate	NA
Goal 4: Water Use Efficiency and Management				
4.1	26% potable water intensity (Gal per gross square foot) reduction by FY 2020 from a FY 2007 baseline (2014 target: 14%)	**ON TARGET** Water use down 44.2%. Significant water savings prior to 2007.	Continue to identify water conservation opportunities. Operational needs require flexible water use goals	Moderate. Additional water conservation projects are limited.
4.2	20% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2020 from a FY 2010 baseline (2014 target: 8%)	**ON TARGET** Water use down 35.9%. Significant water savings prior to 2007.	Continue to identify water conservation opportunities. Operational needs require flexible water use goals	Moderate. Additional water conservation projects are limited.
Goal 5: Pollution Prevention and Waste Reduction				
5.1	Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris, by FY 2015	**EXCEEDED** MSW recycling rate was 77.9%	Continue to maximize waste diversion	NA
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015	**EXCEEDED** C&D recycling rate was 84.1%	Continue to maximize waste diversion	NA
Goal 6: Sustainable Acquisition				
6.1	Procurements meet requirements by including necessary provisions and clauses in 95% of applicable contracts	**MET** >95% for 2014	Procedure ENG-006 includes sustainable acquisition guidance	NA
Goal 7: Electronic Stewardship and Data Centers				
7.1	All core data centers are metered to measure a monthly Power Usage Effectiveness (PUE) of 100% by FY 2015 (2014 target: 90%)	**MET** 100% of data centers are metered	Completed metering of PPLCC in 2013 & consolidation of data centers in 2014	NA

SSPP Goal #	DOE Goal	Performance Status through FY 2014	Planned Actions & Contribution	Risk of Non-attainment
7.2	Core data centers maximum annual weighted average PUE of 1.4 by FY 2015 (2014 target: 1.5)	**ON TARGET** FY14 average PUE=1.55	Additional energy efficiency opportunities for PPLCC have been identified	Moderate. Limited funding for ECMs
7.3	Power management – 100% of eligible PCs, laptops, and monitors with power management actively implemented and in use by FY 2012.	**ON TARGET** Standard desktop/laptop configuration include power management	Planned changes to configuration management programs will allow for improved power management	Moderate. System & cultural barriers. Limited funding for ECMs
7.4	Electronic Stewardship – 95% of eligible electronics acquisitions meet EPEAT standards.	**ON TARGET** >95% of laptops & desktops meet EPEAT standards.	Additional EPEAT eligible electronics regularly added to employee acquisition guidance	Low. Continue to educate employees about EPEAT requirements
Goal 8: Renewable Energy				
8.1	20% of annual electricity consumption from renewable sources by FY 2020 (2014 target: 7.5%)	**ON TARGET** 2014 REC purchases: 1,548 MWh (7.5%)	ESPC and PPA were not financially viable. Continue to explore other renewable energy options.	NA
Goal 9: Climate Change Resilience				
9.1	Address DOE Climate Change Adaptation Plan goals (See Appendix C)	**ON TARGET** PPPL is participating in national and state adaptation planning organizations as programmatic funding can support. PPPL completed the DOE vulnerability assessment survey and is incorporating anticipated climate changes into long-term planning and response documents.		
Goal 10: Energy Performance Contracts				
10.1	Utilization of Energy Performance Contracts	**ON TARGET** ESPCs not financially viable in the past. We will continue to look for opportunities to incorporate alternative financing into campus modernization efforts as programmatic funding and priorities support.		

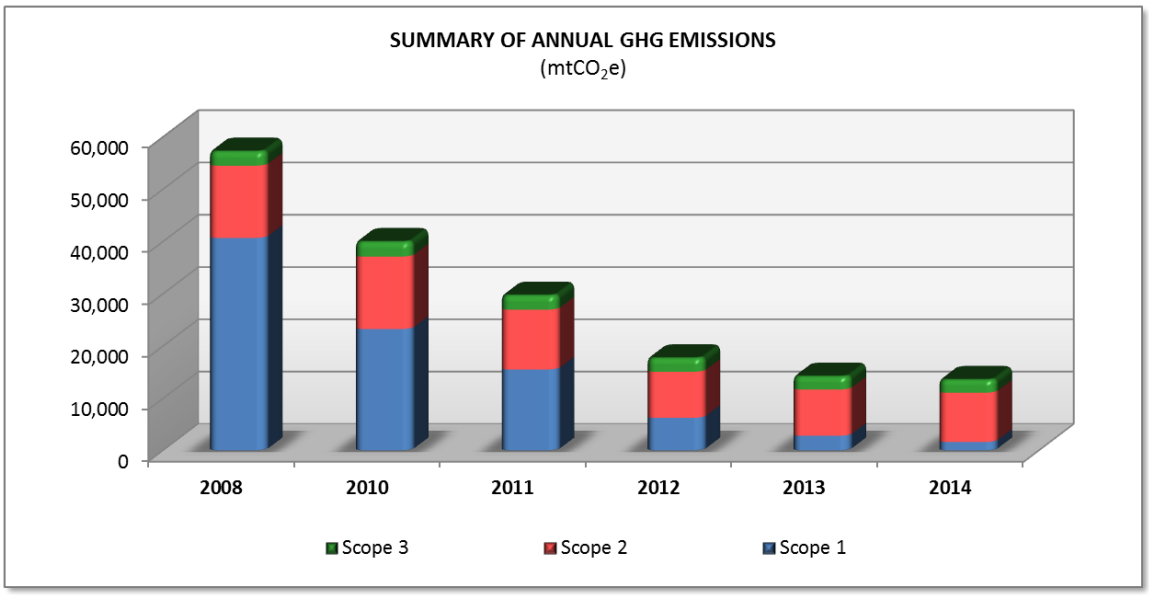

Figure 1 – Annual summary of GHG emissions (mtCO2e), FY2008–2014.

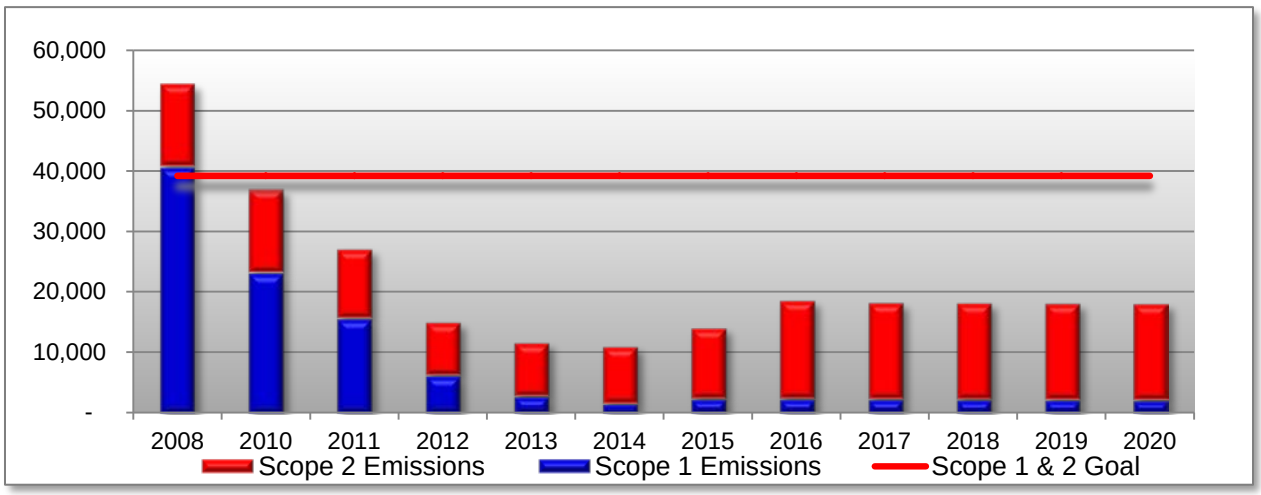

Figure 2 – Actual and projected Scope 1 & 2 GHG emissions (mtCO2e), FY2008-2020.

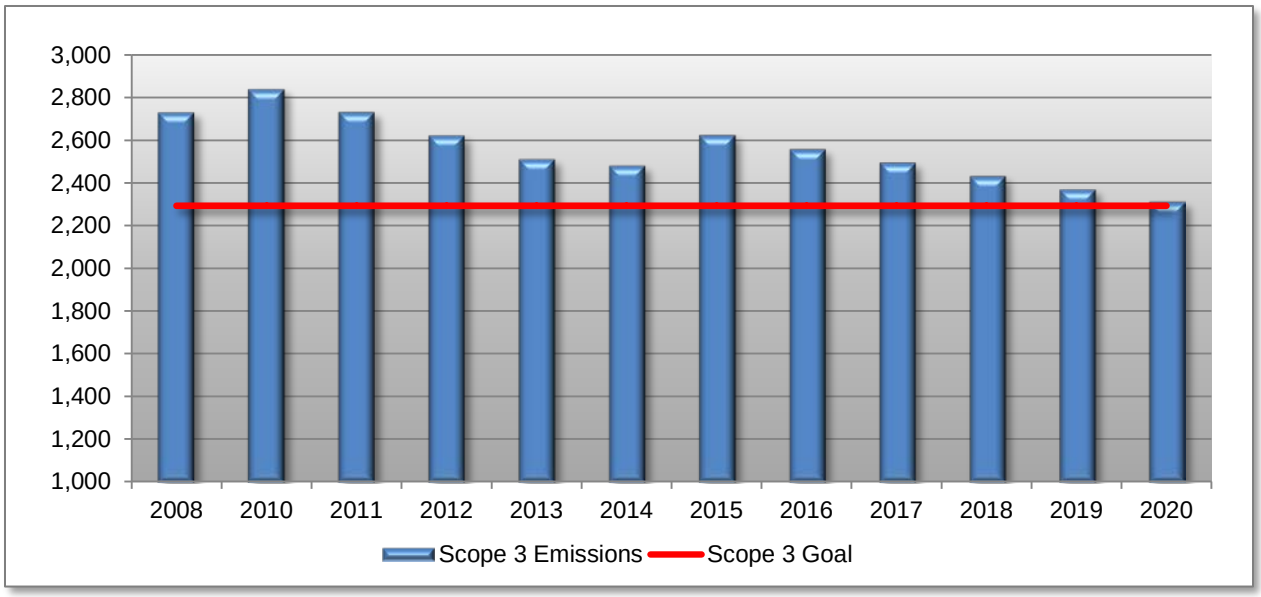

Figure 3 – Actual and projected Scope 3 GHG emissions (mtCO2e), FY2008-2020.

2. Goal Performance Review and Plans

2.1 Goal #1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory

2.1.1 Scope 1 & 2 Greenhouse Gas Reduction

The Princeton Plasma Physics Laboratory (PPPL) will reduce and maintain its Scope 1 and 2 Greenhouse Gas (GHG) emissions below the 28% target for fiscal year (FY) 2020 as compared to the FY2008 baseline. The National Spherical Torus Experiment (NSTX) is undergoing a multi-year upgrade project, known as NSTX-U, to increase its experimental capabilities. Experimental electricity use, and the resulting GHG emissions, is expected to return to near FY2010 levels in FY2015 when NSTX-U systems ramp up for experimental operations beginning in January 2015.

PPPL's Scope 1 & 2 GHG emissions for the baseline year of FY2008 totaled 54,447.4 metric ton CO_2 equivalent (mtCO2e). In FY2010, Scope 1 and 2 GHG emissions had been cut by 32% from the baseline year to 37,051.2 mtCO2e. In FY2011 Scope 1 and 2 GHG emissions were reduced to 27,121 mtCO2e. In FY2014 these emissions were further reduced to 11,020.4 mtCO2e – a reduction of 79.8% from the baseline. Table 2, below, presents a summary of GHG emissions over the past five years.

PPPL may encounter challenges in sustaining this performance if there is other programmatic growth for our fusion energy research and related programs. PPPL's magnetic confinement fusion energy research experiments are energy intensive devices, recreating deep space and stellar conditions in the terrestrial environment. This research is PPPL's primary mission and is dedicated to understanding plasma science and technology and developing a carbon-neutral sustainable global energy source for the future.

In order to maintain its GHG reduction goal, PPPL continues to plan and implement energy efficiency projects and operational improvements as programmatic funding permits. We also continue to focus on reducing fugitive emissions of sulfur hexafluoride (SF_6) which is used in specialized high-voltage equipment supporting its experimental devices. Preparations for NSTX-U experimental operations in FY2015 are expected to result in a one-time purchase of SF_6 to commission experimental support equipment and will include operator refresher training and enhanced control systems for these systems.

Table 2 – Summary of Scope 1 & 2 GHG Emissions, FY2008-2014

GHG CATEGORY	2008	2010	2011	2012	2013	2014
Fugitive - SF_6	38,360.0	21,042.8	13,555.8	4,452.3	1,203.3	0
Purchased Electricity	13,816.0	13,855.0	11,442.6	8,808.7	8,848.6	9,424.5
On-Site Fuel Combustion	2,015.0	1,823.8	1,556	1,336.8	1,280.8	1,391.0
Fugitive - HFCs	160.0	241.2	482.9	345.8	227.8	163.1
Fleet Vehicles	96.4	88.4	83.9	78.0	64.9	41.8
TOTAL (mtCO2e)	**54,447.4**	**37,051.2**	**27,121.2**	**15,021.6**	**11,625.4**	**11,020.4**

The significant reduction in GHG emissions shown in Table 2 is largely due to the focused efforts to control SF_6 losses, which are detailed below. GHG emissions for the on-site combustion of fuel were lower primarily due to improved boiler operations and the use of natural gas for boiler operations over fuel oil. We continue to cut fleet fuel emissions through careful fleet management and the continued use of cleaner burning alternative fuels like E85 and B20. Fleet fuel is discussed in Section 2.3. A graphical summary of Scope 1 and 2 emissions from FY2008 to 2014 is presented in Figure 4, below. Scope 1 GHG emissions have decreased by over 96% from FY2008, mostly due to dramatic reductions in SF6 losses. However, on-site fuel use was reduced 31% and fleet fuel use was reduced by 56.6% during the same period. Scope 2 GHG emissions result only from purchased electricity, and have been reduced by 31.8% from FY2008 to FY2014.

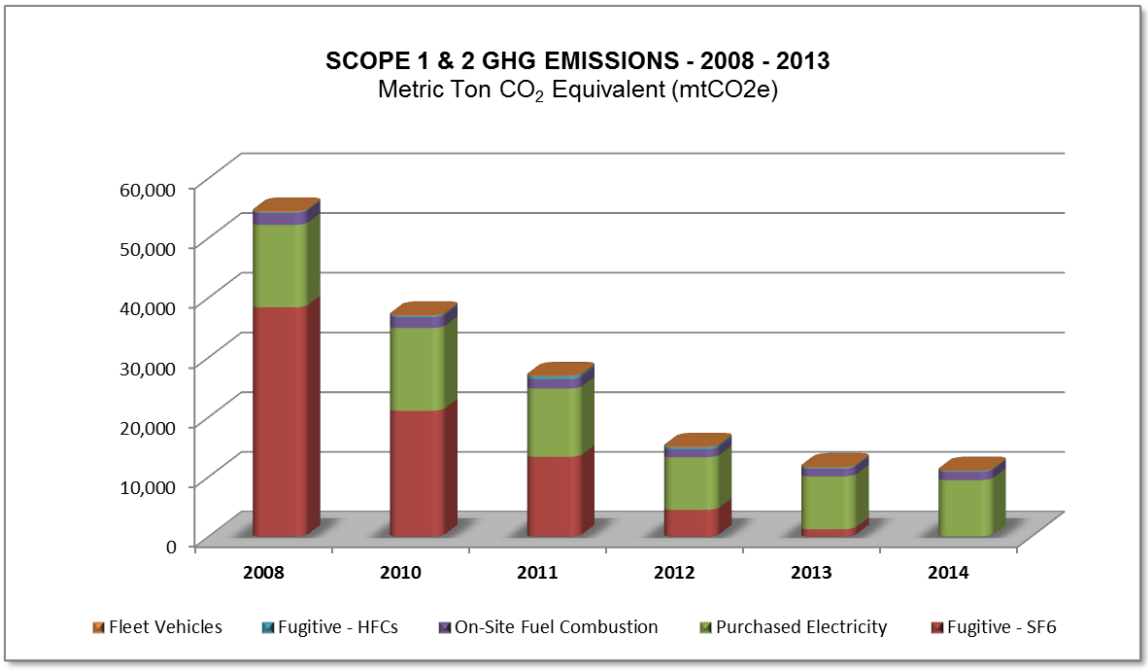

Figure 4 – Summary of Scope 1 & 2 GHG emissions by category, FY2008-2014.

Planned Actions

PPPL will continue to focus on the broad range of actions described in detail above to control SF_6 emissions, improve building energy performance, reduce fleet fuel consumption, and affect employee behavioral changes to reduce our overall GHG footprint. PPPL's ISO14001-certified Environmental Management System (EMS) includes measureable goals to reduce PPPL's GHG footprint and institutionalize the behavioral changes necessary to make PPPL's operations more sustainable.

Sulfur Hexafluoride (SF_6) Emission Reductions

PPPL has a comprehensive program to minimize fugitive emissions from sulfur hexafluoride (SF_6) from high-voltage power systems. This program has resulted in greater than a 96% reduction in annual SF_6 emissions since 2008 and a 95% reduction in the 3-year moving average

SF_6 emissions. In 2008, fugitive emissions of SF_6 accounted for over 67% of PPPL's total GHG footprint, today those same losses are a small fraction of PPPL's total and our total GHG emissions are less than 24% of 2008 levels. This significant reduction is due to the many actions summarized below. PPPL continues to be an active member of the DOE Fugitive Emissions Working Group (FEWG) coordinated by AU-22.

Performance Status:

PPPL operates experimental equipment with high voltage capability that requires SF_6 insulating gas for its voltage standoff properties. Experimental heating systems, namely the Neutral Beam Injection (NBI) and Radio Frequency (RF) systems, are the principal users of SF_6. The NBI uses SF_6 in power supplies, high voltage enclosures, high-voltage transmission lines, and ion source enclosures. The RF system uses SF_6 in six coaxial transmission lines. These lines extend hundreds of feet to reach the experimental areas but have good seal designs and do not usually need entry for maintenance. NBI and RF use an SF_6 recovery and supply skid, a portable reclamation unit, and purchased cylinders to replenish, recover, and store SF_6 inventories. Both the ion sources and their power supply modulator/regulators (M/Rs) have SF_6 molecular sieve scrubbers on them to remove water vapor and maintain very low dew points, providing improved electrical insulating and reducing the chance of electrical arcing and the resulting need to vent contaminated SF_6 to the atmosphere.

PPPL's primary experiment, the National Spherical Torus Experiment (NSTX) is currently in the last year of an upgrade to double the neutral beam heating capacity. A second beam line has been added, which requires three additional ion sources for operations. Experimental power systems which use SF_6 are not in service during the upgrade and the SF_6 inventory has been recovered to the main holding tanks to the maximum extent practical. The upgrade project (NSTX-U) will be completed in FY2015 when experimental operations will resume.

For operations and maintenance, the experimental power systems are filled from and recovered to a central SF_6 skid with minimal loss. The skid is replenished by releasing cylinders into the storage tank inventory for use as needed. RF systems and the Ion Source shop use cylinders to fill sealed volumes for testing and operations. Both of these systems use a portable reclamation unit to recover SF_6 to perform maintenance and testing. The portable unit will also be used to recover transmission line overpressure SF6 captured in the NTC bladder tank.

The NBI and RF groups implemented comprehensive leak rate surveys and leak checks in FY2010 resulting in the repair of any valves, tubing, gauges, and external components found to have minor leaks. Daily rounds and readings are performed for operations that check pressures and identify failures almost immediately.

PPPL implemented several substantial SF_6 capture and recovery system projects beginning in 2011 which were completed in 2014 to support operations in FY2015:

- <u>Transmission Line Overpressure Reliefs:</u> A capture ballast tank system to recover SF_6 from overpressure relief valves on RF transmission lines was designed and installed in FY2011. This system connects pressure relief valves to a bladder tank to capture SF_6 blow-off. The bladder tank is also plumbed into the SF_6 recovery line system which returns SF_6 to the recovery skid. The SF_6 skid can be employed to evacuate the tank and

recover SF_6 captured from the relief valves. This system has been installed and tested and will be in service during NSTX-U experimental campaigns. BL2 has been plumbed into this bladder tank. The portable unit will be used to recover this SF_6.

- Modulator/Regulators (M/Rs): System surveys indicate that the M/Rs have three main problems where the original design of this 30 year old equipment was suboptimal. The High Voltage Switch Tubes (HVSTs) use a fiberglass helmet for SF_6 insulation. The helmet seals and the high voltage bushings connected to the HVST housings were subject to chronic leaks. The redesign and modification of these systems were completed during experimental outages in FY2011. These same modifications have been implemented for the three additional M/R in conjunction with the NSTX-U project.
- SF_6 Pumping and Recovery System: In FY2011 an engineering plan and cost estimate was developed to refurbish the central large-capacity SF_6 pumping and recovery system. By refurbishing this system, PPPL will provide sufficient gas recovery capacity in the event that all NBI systems require purging. Refurbishment of the SF_6 recovery system has been completed in parallel with the NSTX-U project utilizing operations and other project funding. The system was upgraded to incorporate new motor operated valves that are integrated with the new control system. In addition, the recovery tanks and piping systems were dismantled, cleaned and leak-tested to 10^{-3} millitorr vacuum. The new control system includes a mode control software operating system using LabVIEW which has been tested and used prior to the start of NSTX-U operations.

A summary graph of annual fugitive SF_6 emissions in GHG equivalents since the FY2008 baseline year is provided in Figure 5, below. This graph shows that PPPL has reduced dramatically its fugitive SF_6 emissions, contributing significantly to the Laboratory's overall GHG emission reductions.

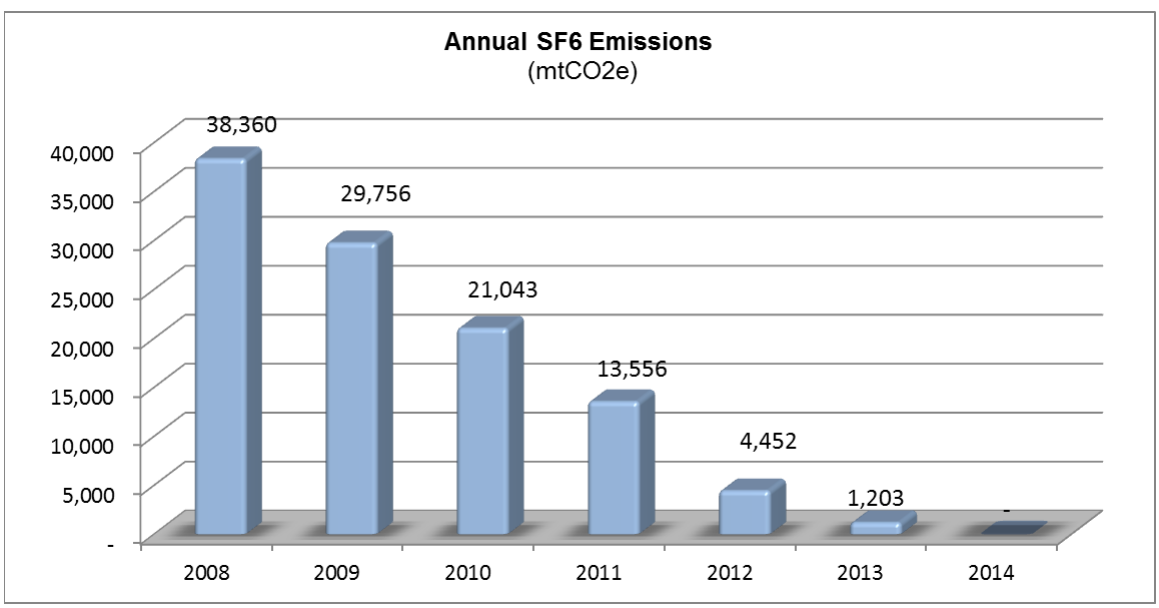

Figure 5 – Summary of annual SF_6 emissions, FY2008-2014.

Planned Actions:

Controlling SF_6 emissions continues to be a high priority for PPPL due to the high global warming potential of this material and plans to begin NSTX-U experimental operations. PPPL will focus on the following SF_6 control and recovery opportunities as we transition back into experimental operations in FY2015:

- Operator Training: For maintenance, when an enclosure has to be entered to affect repairs, a recovery of SF_6 is performed. Residual SF_6 is pumped out and the enclosure volume is vented and purged with air for personnel confined space entry. The recovery and fill operations are performed by trained SF_6 operators. As part of best practices, the SF_6 operators will continue to receive ongoing on the job procedure training to refresh knowledge and awareness of fill and recovery procedures.
- PPPL will also continue to assess potential replacement technologies for SF_6, leveraging the Laboratory's scientific and engineering expertise.

While the age and service conditions of PPPL's experimental heating systems and other SF_6-filled equipment requires vigilance, procedures are in place to minimize SF_6 emissions. Completed and on-going system improvements, continued emphasis on operating procedures, new control systems and operator training will allow us to minimize future SF_6 emissions at PPPL to the extent practical.

2.1.2 Scope 3 Greenhouse Gas Reduction

EO 13514 and DOE's SSPP commits the Department to reduce its Scope 3 GHG emissions by 13% from the FY2008 baseline by FY2020. PPPL voluntarily reported the majority of its FY2008 Scope 3 GHG emissions in December 2009 as part of the Public Sector GHG Reporting Protocol beta testing program. Scope 3 emissions reported for the FY2008 baseline year included business travel, employee commuting, electricity transmission and distribution (T&D) losses, business travel, offsite wastewater treatment and off-site municipal solid waste (MSW) disposal.

Performance Status:

In FY2013, Scope 3 GHG emissions of 2,482.3 mtCO2e representing 18% of PPPL's total GHG emissions and an 11.6% reduction from the FY2008 baseline. Tabular and graphical summaries of PPPL's Scope 3 GHG emissions are provided in Table 3 and Figure 6, below.

Table 3 – Summary of Scope 3 GHG Emissions, FY2008-2014

SCOPE 3 GHG CATEGORY	FY2008 BASELINE	FY2010	FY2011	FY2012	FY2013	FY2014
Employee Commuting	1,211.2	1,153.5	1,204	1,251.9	1,204.9	1,204.8
Electricity T&D Losses	949.7	905.6	753.7	580.3	582.9	620.8
Business Travel	586.1	711.2	718.1	755.9	695.2	626.6
Off-site Solid Waste Disposal	57	66.0	52.4	31.5	25.1	26.5
Off-site Wastewater Treatment	3.6	3.8	4.7	3.7	3.8	3.6
TOTAL (mtCO2e)	**2,807.6**	**2,840.1**	**2,732.9**	**2,623.3**	**2,511.9**	**2,482.3**

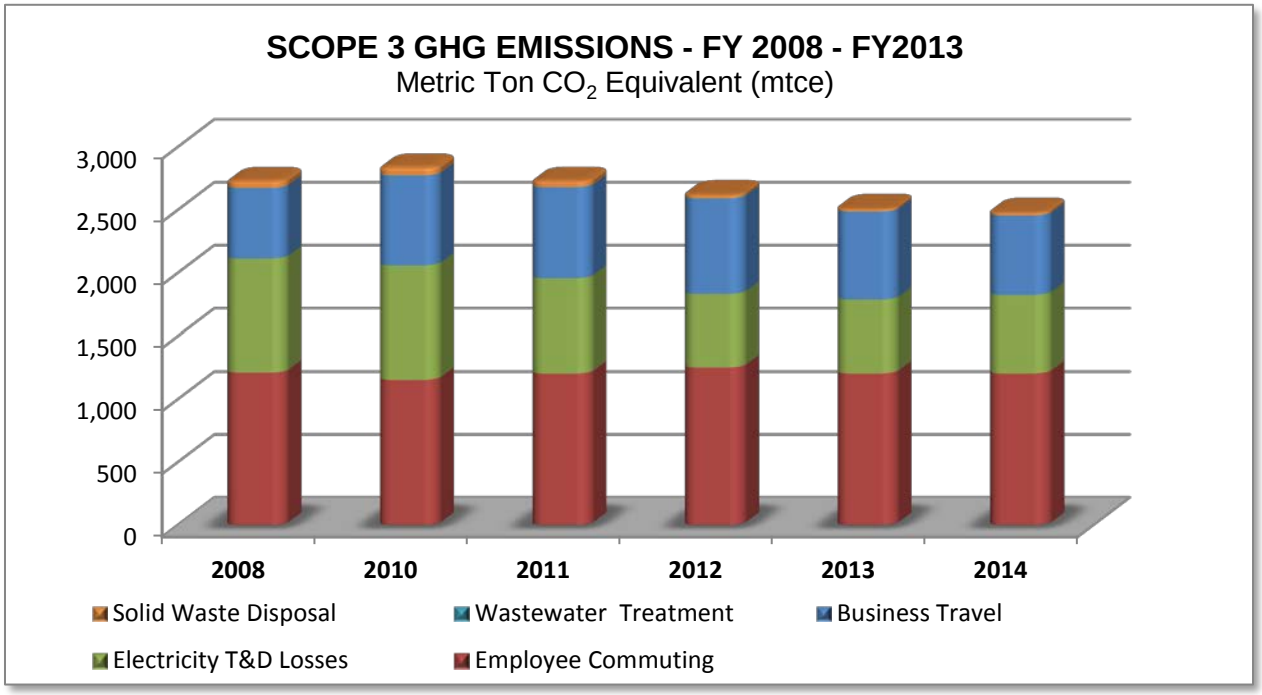

Figure 6 – Summary of Scope 3 GHG emissions by category, FY2008-2014

Employee Commuting: PPPL completed a baseline employee commuting survey in FY2008 as part of a voluntary GHG inventory. The survey was expanded in FY2010 to identify commuting patterns and associated GHG emissions. Over 95% of employees responded to the survey. The survey revealed that over 10% of employees utilize one of these programs or walk/bike to work. Princeton University has a Transportation Demand Management Office, providing employee incentive programs for vanpooling, carpooling, and mass transit use, and has a shuttle that links PPPL with main campus and the regional transportation system. GHG emissions from employee commuting were 1,211 mtCO2e in the baseline year of FY2008. A detailed survey was repeated in November 2013 with 55% of employees participating in the survey. The survey results indicate that the average round-trip employee commute is approximately 36 miles and approximately 18% of employees drive hybrid/alternative fuel vehicles or regularly participate in some form of alternative commuting, including carpools, vanpools, walking bicycling and shuttle services.

In preparing the *FY2014 Site Sustainability Plan* PPPL identified that, prior to the inclusion of GHG calculations for employee commuting in the CEDR, we had used the World Resources Institute calculation methodology, which resulted in lower GHG estimates. PPPL has re-calculated the GHG emissions from those earlier years to yield consistent estimates for GHG emissions based on employee survey data. The commuting data from our 2013 employee survey was used for FY2014, which resulted in no change to emissions for this category. A new employee commuting survey will be conducted in FY2015 to update this GHG category.

Electricity Transmission & Distribution (T&D) Losses: Electricity T&D losses were calculated for the electrical energy used by PPPL as reported in the CEDR spreadsheet. T&D losses are

directly related to electrical energy use and, thus, reductions in electricity use will result in associated reductions in T&D losses. GHG emissions associated with electricity T&D losses were 620.8 mtCO2e in FY2014, representing approximately 4.6% of total GHG emissions. This represents a reduction of 34% from the FY2008 baseline. The start of NSTX-U experimental operations will cause upward pressure on Scope 3 GHG emissions from increased electricity use. These emissions are reflected in the graph of projected Scope 3 emissions shown in Figure 3.

Business Travel: Travel records from FY2014 were used to calculate GHG emissions from air travel in the short, medium and long trip categories. In addition, rental car mileage, limo trips and rail travel were included in the calculation of business travel GHG emissions. GHG emissions calculated for business travel in FY2014 were 626.6 mtCO2e, up from the 588 mtCO2e FY2008 baseline, but showing steady improvement over the past 4 years. PPPL employees traveled over 3.2 million air miles in FY2014 in support of our international collaborative energy research, representing 4.6% of PPPL's total GHG emissions. While international travel in support of the ITER project continues, there was also increased use of video-conferencing which reduced our overall air travel slightly from 2013. PPPL conducts regular video and web conferences with foreign locations in China, France, Japan, Korea, and the UK as well as domestic locations such as Oak Ridge National Laboratory (ORNL), General Atomics, Massachusetts Institute of Technology and the University of Wisconsin.

Off-site Wastewater Treatment: PPPL discharges all sanitary wastewater to the South Brunswick Municipal Utilities Authority for appropriate off-site treatment. Water conservation implemented in previous years will continue to limit the volume of wastewater requiring offsite treatment. FY2014 GHG emissions for off-site wastewater treatment were 3.6 mtCO2e. This figure represents only 0.03% of PPPL's total GHG emissions for FY2014.

Off-site Municipal Solid Waste Disposal: PPPL subcontracts for municipal waste collection and disposal services as well as certain recycling services (paper/cardboard, glass, food waste, concrete, etc.). The current subcontractor is Central Jersey Waste, Inc. Municipal solid waste is collected at PPPL and transported to a permitted solid waste landfill for disposal. PPPL has a mature and effective waste minimization and recycling program. We continue to recycle concrete, asphalt, wood, roofing ballast and other building materials. PPPL has worked with Princeton University to compost leaves and yard maintenance waste and has incorporated recycling requirements into appropriate subcontracts, such as landscaping, renovation and maintenance services. In FY 2014 PPPL diverted 77.9% of the municipal solid waste through single stream recycling and organic waste composting programs. GHG emissions associated with off-site solid waste disposal are down from 57 mtCO2e in FY2008 to 26.5 mtCO2e in FY2014, a decrease of 54%.

Planned Actions:

Employee Commuting: PPPL continues to promote the programs offered by Princeton University to encourage employees to use mass transit, car pools and van pools. Further reductions will require significant policy changes such as flex time or expanded work days requiring University and DOE approval. PPPL will conduct a new employee commuting survey in FY2015 and update the GHG emissions based on the new survey.

Business Travel: PPPL will continue efforts to encourage employees to utilize video, web, and teleconferencing services in lieu of travel. PPPL routinely conducts video and web conferences to foreign and U.S. locations. Where feasible, train travel is encouraged over short-haul airline travel. The sustained reduction of GHG emissions related to employee business travel may be difficult to meet in the face of growing or changing site missions that increase the number and extent of international scientific collaborations, especially the ITER Project.

Electricity Transmission & Distribution (T&D) Losses: PPPL will continue its low-cost energy efficiency efforts in order to reduce electrical energy use. We have identified many opportunities for the energy efficiency projects, including the introduction of on-site renewable energy. Implementation of these projects is severely limited by the current lack of infrastructure funding. We also recommend that calculations for T&D losses be performed using emissions factors from the utility provider when available. This change would enable DOE to account for improvements in the electricity grid as they are implemented by electric utilities.

Off-site Wastewater Treatment: PPPL will evaluate additional water conservation projects to reduce wastewater discharge. In past years, PPPL has installed low-flow fixtures throughout the facility and has identified and redirected industrial and process water discharges to the sanitary sewer that unnecessarily increased wastewater flow. With off-site wastewater treatment representing less than one percent of PPPL's overall GHG footprint, there are higher priority GHG reduction measures that will require more attention in the near term.

Off-site Municipal Solid Waste Disposal: PPPL will continue to emphasize its mature and effective waste minimization and recycling programs to reduce the amount of solid waste shipped offsite for disposal. The food/organic waste composting program continues to expand and improve. Our cafeteria subcontractor emphasizes compostable food service items and our composting program is becoming more effective in reducing waste. Our waste hauler is participating in a single stream recycling program in our county, which was also implemented at PPPL. PPPL will continue to identify and act on opportunities to reduce the volume of MSW waste shipped off-site for disposal, which will help reduce Scope 3 GHG emissions.

2.2 Goal #2: Buildings, ESPC Initiative Schedule and Regional & Local Planning

2.2.1 Energy Intensity Reduction

The Energy Independence and Security Act of 2007 (EISA 2007) requires Federal agencies to reduce their energy intensity by 30% by FY2015 from a FY2003 baseline.

Performance Status:

PPPL's current energy utilization intensity (EUI), based on its Consolidated Energy Data Report (CEDR) for FY2014, is 106,447 Btu per gross square feet of building (106 kBtu/gsf), which is a 39.8% reduction as compared to the FY2003 baseline of 176,759 Btu/gsf (176.8 kBtu/gsf). For

the past seven consecutive fiscal years PPPL has exceeded the 30% EUI reduction goal established for FY2015 and will continue to pursue life-cycle cost effective energy efficiency improvements as funding allows. A graph of PPPL non-exempt EUI from 2003 to 2014 is shown in Figure 7, below. The red line in this graph represents the FY2015 EUI reduction goal of 30%. Last winter, the northeaster US experienced one of the coldest winters in recent history. With a 10% spike in heating degree days from FY2013 to FY2014, PPPL experienced significant increase in the energy use for space heating, yet has managed to comply with the EUI reduction goal.

The Lyman Spitzer Building (LSB), our main administration/office building is certified as LEED-Gold under the U.S. Green Building Council (USGBC) Leadership in Energy & Environmental Design (LEED) rating system and has met the five Guiding Principles for 2013. This building is over 119,000 square feet and supports approximately 200 employees (45% of Laboratory employees). These employees include research and support personnel who are responsible for Laboratory management, accounting, payroll, procurement, and operations. The LSB also includes the control room for PPPL's largest experimental device the National Spherical Torus Experiment Upgrade (NSTX-U).

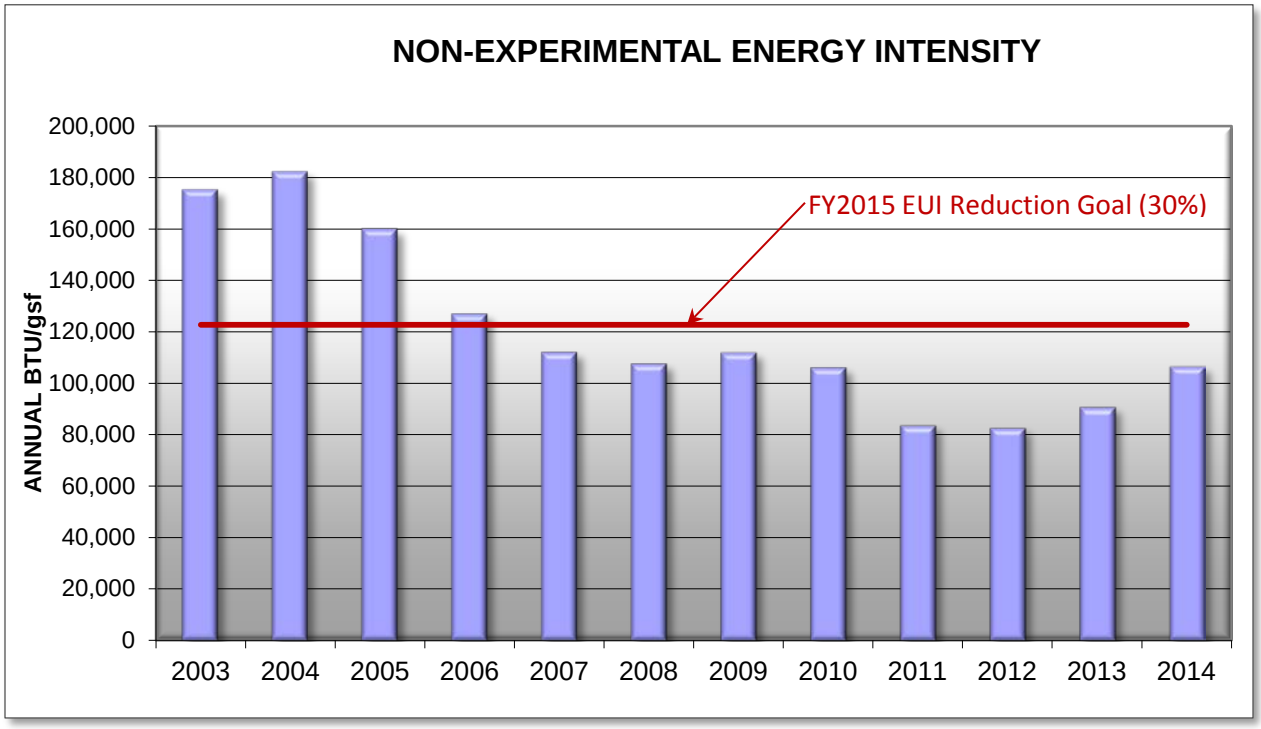

Figure 7 – Non-exempt energy utilization intensity (EUI) in Btu/sf, FY2003-2013.

PPPL has implemented several energy conservation measures (ECMs) to achieve our current energy intensity reduction. Three-way valves on the chilled water system were replaced with two way valves, thus reducing unnecessary water pumping. Throughout FY2013 and FY2014, Phase II continued efforts to insulate pipes where steam and hot/cold water pipes were insulated, replacing old 1-inch fiberglass insulation with 2-inch earthwool insulation.

Lighting in most areas of the Laboratory is controlled with occupancy sensors and/or managed by PPPL's central Building Automation System (BAS) to minimize unnecessary electrical use. PPPL will continue to evaluate and implement additional lighting controls in conjunction with HPSB and building condition assessments.

PPPL published and implemented a new Energy Policy in FY2013. Throughout FY2014, PPPL continued to implement the new policy and plans for continuous improvement with updates to these requirements in FY2015. The policy's intent is to address the need for conservation awareness and/or behavioral change, as well as be used as a guide for the PPPL community to incorporate energy saving actions into daily activities. Part of PPPL's energy policy is a continued focus on purchasing and operating ENERGYSTAR® products. Currently, more than 90% of desktop and laptop IT equipment purchased are EPEAT certified, and ENERGYSTAR® products are the default for the purchase of new electrical appliances and equipment.

PPPL has embarked on a potable water usage reduction program. We have converted several experimental uses of potable water to closed loop chilled water systems. Surveys were performed in FY2014 throughout the site to identify potential locations for future water meters. One of these identified locations did receive a new meter in FY2014 and this meter was added to PPPL's BAS for visibility and tracking. .

Planned Actions:

PPPL's goal is to build a safe, efficient, and modern campus that showcases efficient use of energy and renewable sources while ensuring our researchers and collaborators can continue to conduct world-leading research in fusion energy and plasma science and technology.

The PPPL Campus Modernization Plan, published in July 2014, supports this goal while addressing aging infrastructure and modernizing existing space with investment in site design and building development that maximizes energy efficiency and renewable energy opportunities. Throughout FY2015, PPPL plans to where possible design and initiate plans for high performance, low-energy consuming facilities through a variety of financing mechanisms that help minimize PPPL's energy footprint while accommodating campus growth.

PPPL's planned actions include the identification and implementation of energy efficiency projects that are lifecycle cost effective in order to continue to reduce the energy intensity of its operations. PPPL selects projects primarily by evaluating life-cycle costs (less than or equal to 5-year simple payback is the initial goal). Tab 3.3a of the Consolidated Energy Data Report (CEDR) spreadsheet lists projects that, if funded and implemented, have the potential to greatly reduce energy intensity. Planned facilities, along with estimates of their future energy consumption, are listed in the "New Construction" tab of the CEDR. New buildings and major renovations will meet the Guiding Principles and will be designed to be low-energy consumption with an ENERGYSTAR® target rating of 90 or above.

PPPL has identified the following activities to further reduce energy intensity in FY2015. Additional projects are identified in the CEDR submittal, pending the availability of funding.

- Update and broaden the application of PPPL's Energy Policy. With the renovations and/or new construction envisioned in the Campus Modernization Plan, PPPL will work to develop

additional sections to the PPPL Energy Policy focused on incorporating energy saving opportunities, where economically feasible, as requirements for major renovations and new constructions to comply with EPACT2005 and EO134323 for such projects.

- Continue to insulate hot and cold water pipes, replacing old 1-inch fiberglass insulation with 2-inch earthwool insulation.
- Energy-efficient lighting is standard practice in office and hallway renovation projects.
- Identification of commissioning and retro-commissioning opportunities.
- Audits for Federal green building performance.
- Identification and audits for low-cost, no-cost opportunities to eliminate energy waste in existing facilities.

In addition to the projects noted above, PPPL's Facilities Division has adopted important ongoing sustainability efforts as part of its maintenance and renovation activities. These efforts include office, shop and lab renovations that incorporate energy efficient lighting and the extensive use of sustainable building products.

One project that stands out in this area is PPPL's Demand Flow project focused on a holistic approach for optimizing PPPL's chilled water plant performance and achieving savings in several areas of the chilled water system. This project is currently in the design phase and is planned for execution in FY2015. At the heart of the Demand Flow ™ solution are algorithms that control and sequence the entire chilled water plant. These control algorithms will optimize the plant's operation and seek energy efficiency through:

- Controls requiring select pumps, both condenser and chilled water, along with cooling tower fans, to employ Variable Speed Drives (VFD's),
- By means of these control algorithms, temperature set-points for chilled water and condenser water are optimized and maintained accurately, while the speed of all pumps and tower fans are controlled to optimize the energy expended for a given tonnage load,
- Chiller ON/OFF sequencing is greatly simplified and does not require elaborate equipment curve selection analysis.

PPPL currently has six buildings excluded from the energy intensity goal. These buildings represent 234,377 gross square feet of building space, or 31%, of PPPL's overall building footprint, and they house critical experimental devices and support systems. The Radioactive Waste Handling Facility (D-35) was removed from the excluded building list in FY2012 since it does not meet the excluded building criteria. PPPL has submitted the required waiver from the energy intensity reduction goals for these experimental facilities, but continues to develop and evaluate energy efficiency improvements that can be implemented in these areas. These projects will continue to be considered for implementation under our GPP and OPEX programs. PPPL's CEDR submittal (Tab 3.3a) identifies numerous potential energy efficiency projects for experimental systems that do not currently have funding available.

In FY2014 the National Spherical Torus Experiment (NSTX), entered the final phase of a major upgrade to PPPL's flagship experimental device. The upgrade added significant additional plasma heating capabilities in the form of an additional neutral beam line, doubled the plasma current, enabled longer experimental pulses, and added other capability enhancements.

However, the overall electrical power consumption for NSTX-U is expected to be flat due to a longer duration between experimental pulses under the new operating regime compared to previous NSTX operations.

Barriers:

The continued implementation of energy efficiency, water conservation and other sustainability improvement projects will be at risk under repeatedly flat or declining budgets. Safety, corrective maintenance and mission-critical work will take priority over sustainability projects, which may not leave sufficient remaining funds for sustainability projects. The continued implementation of energy efficiency, water conservation and other sustainability improvement projects will be at risk if budgets return to pre-FY2015 levels. PPPL estimates that a minimum of $8 million annually is needed to effectively cover required any improvements activities above safety, corrective maintenance and mission-critical work.

2.2.2 EISA Section 432 Energy & Water Evaluations

PPPL reports the Energy Independence and Security Act of 2007 (EISA07) covered facility energy use in the CEDR. PPPL's facilities represent the major energy consumers and opportunities for energy efficiency improvements on the PPPL campus. EISA07 directs that ongoing evaluation of facilities be performed on a four-year cycle. This four-year cycle of activity includes evaluating facilities, identifying and implementing projects, and following up on and maintaining efficiency measures as part of the re-evaluation process to ensure an ongoing cycle of continuous improvement. PPPL completed its first cycle in FY12 with 100% of facilities evaluated. PPPL submitted its most recent EISA report June 2014.

Performance Status:

PPPL completed 100% of building evaluations in 2008, the first year of the four-year cycle receiving credit for 100% for the first four-year cycle. A new cycle was initiated in 2013, and PPPL has completed evaluations of at least 25% of its buildings.

In order to develop its Campus Modernization Plan in FY2014, PPPL surveyed 100% of campus facilities, including both High-Energy Mission-Specific Facilities (HEMSFs) and non-HEMSF buildings with respect to condition and suitability for designated mission.

PPPL has initiated benchmarking of campus facilities in the EPA Portfolio Manager tool. Using Portfolio Manager, PPPL plans to assess energy performance, water efficiency, and carbon emissions for each campus facility where possible against the national averages.

Planned Actions:

PPPL plans to evaluate at least 25% of its facilities in FY2015 in order to comply with this goal and with EISA07. The EISA evaluations will be used to identify new 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.

2.2.3 Building Energy Metering

PPPL has completed the installation of energy meters, either advanced or standard, to the maximum extent practicable in buildings and other facilities for electricity, natural gas, steam, and water as required by EPACT05.

Performance Status:

Advanced Electric Metering: PPPLs' Advanced Electrical Metering Plan has been submitted annually since FY2007, as required by EPACT05. In FY 2011 two advanced electric meters were installed at PPPL main computer center area (PPLCC), however these meters do not meter separate buildings. A third meter was installed to measure non UPS supplied computer systems and allow accurate PUE calculations in order to assess compliance with the PUE requirements for FY2014. The PPLCC is part of a larger building that is not metered. PPPL currently has 39 advanced electrical meters, including meters for the main site-wide electrical service. Building- and system-level metering represents over 50% of site-wide electrical consumption. For CEDR purposes only six (6) advanced meters were listed since only six buildings are metered separately.

Steam & Natural Gas Metering: Natural gas meters have been installed in all buildings using natural gas as the primary heating source of energy: Module #6, Site Protection Building, and CAS/RESA Building. A new HVAC unit with natural gas supply for the Princeton University High Energy Physics tenant has a separate natural gas meter. Steam metering exists on the Lyman Spitzer building (LSB) and is connected to the PPPL Building Automation System (BAS) for remote reading of the meters and recording ENERGYSTAR® data. The new LSB front entrance snow melt system has a separate steam meter so the system will not count as building heat energy against the ENERGYSTAR® rating of the LSB. One advanced steam meter was installed in Engineering Wing during FY2011. Additional steam meters were installed in the Warehouse and Facilities buildings and on the steam supply to D-Site. Finally, each boiler in the central steam plant is now equipped with individual gas and steam meters. These meters are connected to the BAS to allow for performance monitoring through data collection and trending. For CEDR purposes only four (4) advanced meters were listed since only four buildings are metered separately.

Planned Actions:

PPPL's plan for new sustainable buildings is in alignment with PPPL's Campus Modernization Plan. The planned footprint incorporates comprehensive metering in throughout the campus, thus allowing PPPL's users to be more aware of how utilities are being consumed by each individual building. This will support the shaping the behavior of the campus community and support the identification of areas for energy conservation improvement.

2.2.4 Cool Roofs

PPPL has four (4) cool roofs installed. PPPL will enhance overall building thermal performance by ensuring that all new roofs and roof replacements will have a thermal resistance of at least R-30, consistent with Secretary Chu's memorandum of June 1, 2010. Because PPPL is located near

the boundary between U. S. Department of Agriculture (USDA) Climate Zones 4 and 5, highly reflective cool roofs are not always clearly cost effective over the lifecycle of the installation.

Performance Status:

PPPL installed its first cool roof in 2005 on the Admin building (Building C-13) totaling 20,000 square feet. This roof is an ENERGYSTAR® rated Carlisle Corp. EPDM "Sure Seal" reflective roof with an average insulation value of R-30. In 2010, PPPL installed a 16,500 square foot R-30 rated roof on Building C-20, Engineering Wing, however this was not considered a cool roof under DOE guidelines. PPPL's engineering standards for roofs have been updated to require R-30 and applicable cool roof specifications for facility improvements and new construction.

In FY2012, the Lyman Spitzer Building (LSB), PPPL Computer Center (PPLCC) and C-Site MG Building Low-bay area received new R-30 cool roofs. These roofs are Carlisle "Sure-White" fleece-backed white EPDM consisting of a 90 mil white membrane with 55 mil fleece backing with a 30 year warranty and underlain with R-30 insulation. The LSB was divided into three projects. A 29,605 square foot R-30 cool roof was installed on 81% of the building. The auditorium, which constitutes 7% of the building, received a 2,418 square foot R-30 cool roof. The remaining 12% of the LSB roof was fitted with a 2,174 square foot R-30 black roof and a 2,174 square foot R-30 cool roof. This 12% section of the roof was equipped with temperature and heat flux sensors to gather data to compare the performance of white and black roofs in the region. Our research analysis shows that while membrane reflectivity (albedo) plays a dominant role in reducing the heat conducted inward through the roof structures during the warmer months, insulation thickness becomes the main roof attribute in preventing heat loss from the buildings during colder months. Insulation thickness, apart from reducing the heat conducted through the roof structure, also delayed the transfer of heat, owing to its thermal capacity. This has important implications for determining the peak heating and cooling times and their impact on building energy management practices.

Finally, the PPLCC received a 5,959 square foot R-30 cool roof. Finally, an R-30 cool roof was also installed on the low-bay portion of the C-Site MG Building. These projects have resulted in a total of over 80,000 square feet of energy-efficient roofing representing approximately 16% of PPPL's total roofing.

Planned Actions:

PPPL's standard roofing specification calls for a minimum R-30 insulation for all future roof installations.

2.2.5 HPSB Goal Progress

This section discusses the status and plans to achieve high performance sustainable building (HPSB) goals. EO13423 requires that at least 15 percent of enduring buildings are compliant with the Federal Guiding Principles for High Performance Sustainable Buildings. EO 13514 and the DOE SSPP revised the goal to be 15% of the number of buildings – not square footage – and that only a building greater than 5,000 square feet (sf) are subject to the goal. Additionally, EO

13514 and the SSPP require 15% by FY2015, while stipulating continued progress towards 100%.

Performance Status:

The LSB achieved LEED-EBOM® Gold certification under the U.S. Green Building Council's (USGBC) Leadership in Energy & Environmental Design LEED® rating system in April 2011 and has meet the five Guiding Principles for 2013. This building is about 119,000 square feet and supports approximately 200 employees (45% of Laboratory employees). The LSB also includes the control room for PPPL's flagship experimental device the National Spherical Torus Experiment-Upgrade (NSTX-U).

Planned Actions:

PPPL will prioritize HPSB infrastructure projects on those buildings identified with the greatest potential for meeting the Guiding Principles to meet the 15% HPSB goal, with a long-term objective of 100% HPSB buildings. It must be noted that meeting the goal of having 100% of PPPL buildings qualified as HPSBs under the Guiding Principles is not feasible in the near-term with current GPP and maintenance funding. ENERGYSTAR® Portfolio Manager is used to document progress in meeting these goals. Renovations or other building improvements required to meet the Guiding Principles will be incorporated into PPPL's OPEX and GPP planning process for inclusion in out-year plans. It is anticipated that the current level of GPP and OPEX funding will not be sufficient for all the required improvements. Five buildings have been identified for evaluation and three are targeted for upgrades to meet the Guiding Principles by FY2015, pending funding availability. Additional HPSB progress in the form of high-efficiency building retrofits and renovations is outlined in PPPL's Campus Modernization Plan which outlines a 10-year vision to transform the Laboratory's infrastructure to support future scientific missions and enhance our energy and environmental performance.

2.2.6 New Construction

Executive Order 13423 stipulates that all new buildings and major renovations must meet the Guiding Principles for Federal Leadership in High-Performance and Sustainable Buildings (Guiding Principles). In addition, per Section 109 of EPACT05, all new buildings in design shall be designed such that their energy consumption is 30% below applicable American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards.

Performance Status:

PPPL does not currently have new facility construction projects that have progressed beyond the Critical Decision Zero (CD-0) stage.

Planned Actions:

The PPPL Campus Modernization Plan encompasses the entire efforts by collecting and organizing key priorities and establishing key milestones for new construction goals. Throughout

the Plan, potential new construction proposals incorporate energy and water management goals and requirements to support the efficient management of resources while mitigating the related costs. The planned actions found in PPPL's Campus Modernization Plan presents new challenges to PPPL to further prioritize energy reduction, as well as, carbon abatement strategies to further the DOE's mission.

As discussed in more detail in Section 2.8, PPPL has pursued on-site renewable power projects of approximately 1 MW in size through both Energy Savings Performance Contract (ESPC) and Power Purchase Agreement (PPA) processes. These projects were found not to be financially viable. While not successful in bringing on-site power generation to PPPL, they identified key institutional, policy and statutory barriers to implementation. PPPL will continue to purse smaller scale renewable power systems where suitable and where infrastructure funding is available. We will continue to evaluate alternative financing options, such as combined ESPC-PPA options for financial viability under continued budget constraints. Infrastructure funding to support such projects continues to be severely limited under current budget constraints.

2.2.7 Regional & Local Planning

PPPL is located at the Princeton Forrestal Center (PFC); Princeton University's 2,200 acre planned mixed commercial, office, research and residential development. Princeton University's mission in planning and developing PFC was to protect and enhance the quality of life in the region as Central New Jersey experienced significant population growth and development. It did this by implementing a master plan that protects the land's natural systems, requires high quality design, and anticipates the expanding mobility and infrastructure requirements of the region. PPPL's overall site development, including the amount of impermeable cover (paving, buildings, etc.), are controlled by the PFC Master Plan. As part of PFC, PPPL is integrated into the regional planning process. PPPL has invested recently in significant beneficial landscaping and exterior infrastructure projects to facilitate pedestrian traffic and enhance wildlife habitat at the site.

PPPL's Campus Modernization Plan, published in July 2014, outlines a 10-year vision to transform the Laboratory's infrastructure to support future scientific missions and enhance our energy and environmental performance. The Plan focuses primarily on the modernization of existing facilities and infrastructure with a future campus vision that includes new modern energy-efficient lab, office and storage spaces. All proposed refurbishment and new construction takes place within the developed portion of the site and do not disrupt the surrounding open spaces.

Princeton University has a Transportation Demand Management Office, providing employee incentive programs for vanpooling and mass transit use, and has two shuttles that link PPPL with main campus and the regional transportation system. PPPL continues to participate in other transportation management programs coordinated by the Greater Mercer Transportation Management Association.

2.3 Goal #3: Fleet Management

2.3.1 Alternative Fleet Fuel

EOs 13423 and 13514 require agencies to increase alternative fuel use by 10% annually through FY 2015 against the FY2005 baseline. PPPL has already exceeded this goal by expanding the use of E85 and B20. Alternative fleet fuel use in FY2014 was 13 times higher than FY2005. This represents 48% of PPPL's total covered fleet fuel use (see Figure 8, below).

The General Services Administration (GSA) Federal Automotive Statistical Tool (FAST) system converts the 20% biobased portion of B20 fuel to B100 for reporting purposes and the remaining 80% petroleum fraction is reported as regular diesel fuel. PPPL's data reflect this reporting protocol.

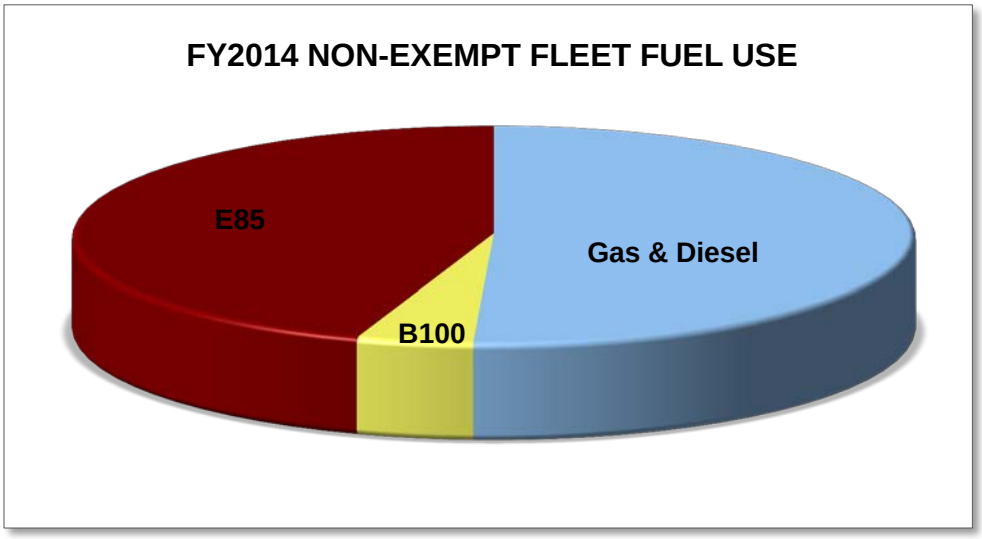

Figure 8 – FY2014 non-exempt fleet fuel use by type.

2.3.2 Petroleum Fleet Fuel

EOs 13423 and 13514 require agencies to decrease fleet petroleum consumption by 2% annually FY 2015 against the FY2005 baseline (30% by FY2020). PPPL continues to exceed this goal through its extensive use of alternative transportation fuels. Fleet petroleum consumption was 70% below the FY2005 baseline (see Figure 9, below). The red line in Figure 9 represents to FY2020 goal of a 30% reduction from the FY2005 baseline.

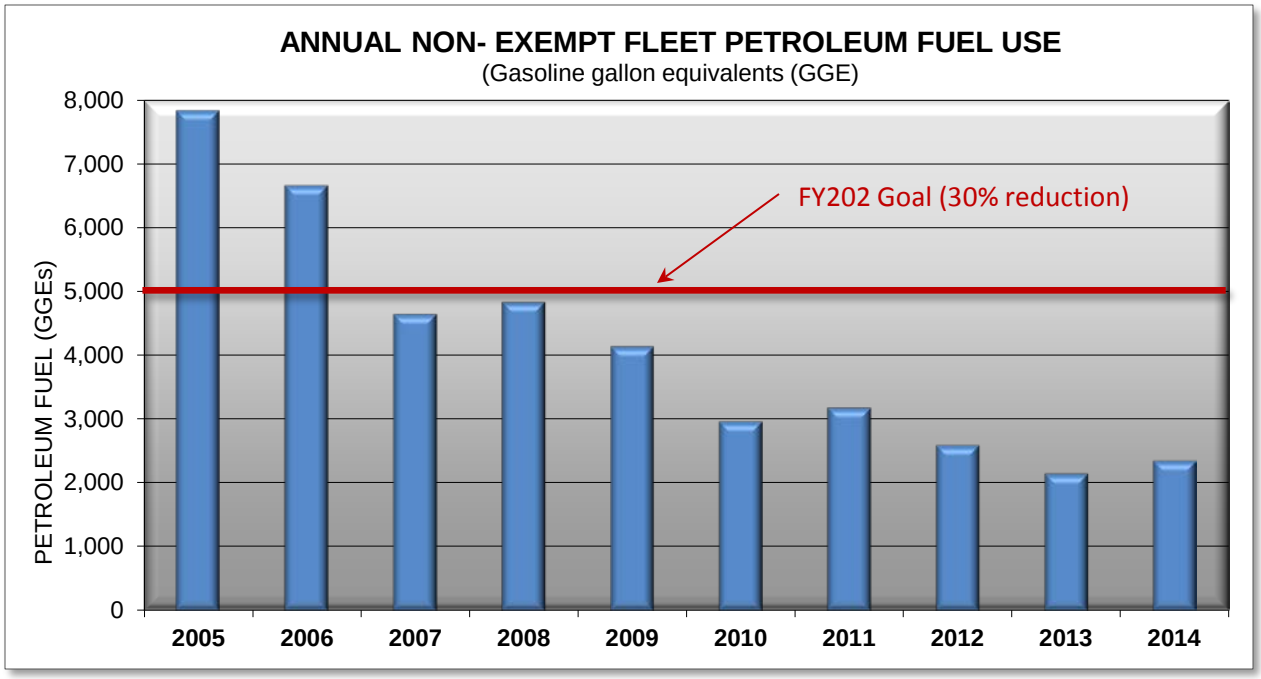

Figure 9 – Annual non-exempt fleet petroleum fuel use, FY2005-2014.

2.3.3 Alternative Fuel Vehicles (AFVs)

PPPL continues to exceed the goal for 75% acquisition of alternative fuel vehicle (AFV) for light duty vehicles by FY2015. PPPL specifies only AFVs as replacement lease vehicles through the GSA whenever a suitable AFV is available. Our current fleet, including exempt emergency vehicles, consists of 23 vehicles: one (1) DOE owned fire truck (B20) and (22) GSA leased vehicles. Of the 22 GSA leased vehicles we have three (3) electric hybrid, (18) vehicles using alternative fuels (E85 and B20), and one (1) vehicles using exclusively petroleum fuel (gasoline or diesel). Thus, 96% of PPPL's fleet is made up of alternative fueled vehicles (AFVs). In addition to the use of alternative fuels in its covered fleet vehicles PPPL uses B20 in several pieces of heavy-mobile equipment, including a 15 ton forklift, backhoe, and skid steer loader(s). PPPL's fleet of John Deere Gator® and similar neighborhood vehicles runs exclusively on B20. PPPL's on-site fleet refueling station supports the storage and dispensing of E85 and B20 fuels.

2.4 Goal #4: Water Use Efficiency and Management

2.4.1 Potable Water Intensity

EO 13514 establishes the following goals for Federal agencies with respect to water conservation and efficiency:

- potable water, reducing water intensity by no less than 16% by FY 2015 relative to the established FY 2007 baseline.

Performance Status:

It should be noted that PPPL operations require cross-connection capability between the potable and non-potable water systems. This cross-connection is necessary to ensure sufficient water for non-contact cooling and fire protection purposes in the event that the D&R Canal Pump House is off-line. Thus, operational conditions may result in dramatic annual fluctuations in potable water use. Total water use is a more useful measure at PPPL.

PPPL made significant progress in water conservation prior to the FY07 baseline year. Our efforts began in 1996 and continue to progress to the present time. Five significant efforts have been implemented since 1996 to conserve potable and industrial (process) water with combined usage in FY1996 of over 124 million gallons to the FY2007 baseline value of 13.96 million gallons, a reduction of over 88%. Proactive water conservation practices implemented prior to Executive and DOE Orders reduced water consumption at PPPL and presents additional challenges in achieving the reduction goals. In FY2014 PPPL used 3.04 million gallons of potable water, a 44% decrease from the FY2007 potable water baseline of 5.45 million gallons.

Several conservation measures were implemented during FY2013 and the results of these measures were seen in the dramatic reduction in FY2014. These measures included:

- Two coolant recirculating chillers suitable for use with closed loops have been installed during the last quarter of FY2013 to replace once through use of potable water form equipment cooling. This action showed a 172,800 gallon reduction in FY2013 and is estimated to be the greatest contributor to the 44% reduction in potable water. Annually this conservation measure is expected to contribute approximately to a 600,000 gallon annual reduction.
- Elevated water tower valve testing methodology was revised to test once per quarter rather than once per month. This action saves PPPL about 300,000 gallons of potable water per year.

Planned Actions:

Past success in reducing potable water consumption presents a challenge in identifying new conservation measures. PPPL is conducting a potable water system survey to identify areas for improvement and meter locations to better manage the system. Additionally PPPL will continue to identify once through cooling systems operating in potable water and changing them to coolant recirculating chillers suitable for use with closed loops where possible. PPPL's Campus Modernization Plan supports this goal while addressing aging infrastructure and modernizing existing space with investment in site design and building development that maximizes energy and water efficiency and renewable energy opportunities.

2.4.2 Industrial, Landscaping & Agricultural (ILA) Water Intensity

EO 13514 establishes the following goals for Federal agencies with respect to water conservation and efficiency:

- 20% reduction of Industrial/Landscaping/Agriculture (ILA) water consumption is being sought by FY2020 from a FY2010 baseline.

As discussed above, PPPL operations require cross-connection between the potable and non-potable water systems. This cross-connection is necessary to ensure sufficient water for non-contact and fire protection purposes in the event that the D&R Canal Pump House is off-line. Thus, operational conditions may result in dramatic annual fluctuations in potable water use. Total water use is a more useful measure at PPPL.

Performance Status:

PPPL made significant progress in water conservation prior to the FY07 baseline year. Our efforts began in 1996 and continue to progress to the present time. Several significant efforts have been implemented since 1996 to conserve potable and industrial (process) water with combined usage in FY1996 of over 124 million gallons to the FY2007 baseline value of 13.96 million gallons, a reduction of over 88%. In FY2014 PPPL used a total of 7.75 million gallons of water, a reduction of 44.5% from the FY2007 baseline of 13.96 million gallons. In FY2014 PPPL used 4.71 million gallons of process water, a 27% reduction from the FY2010 baseline of 6.49 million gallons. The combined annual total of 12 to 16 million gallons of potable or process water represents a stable and necessary level of water use for the facility.

Measures implemented to date include:

- Adjusting boiler plant steam pressure and improving condensate returns, resulting in 550,000 gallons per year.
- Replacement of a 15 year-old water-cooled air conditioning unit with an air-cooled direct expansion saving 5.5 million gallons per year.
- Replacement of two water-cooled air compressors with air cooled compressors saving 7.8 million gallons per year.
- Improved cooling tower operations and equipment upgrades to reduced system blowdown saving approximately 3.8 million gallons per year.
- Replace three way valves on the chilled water system with two way valves.

It should also be noted that NSTX did not run during FY2014 and will not run again until FY2015. Non-contact cooling water use is expected to increase again when NSTX-U begins experimental operations in FY2015.

Figure 10, below provides a summary of potable, ILA and total water use from 2000 to 2014. PPPL does not routinely irrigate lawns or landscaped areas. Water is used only temporarily for irrigation of new landscaping.

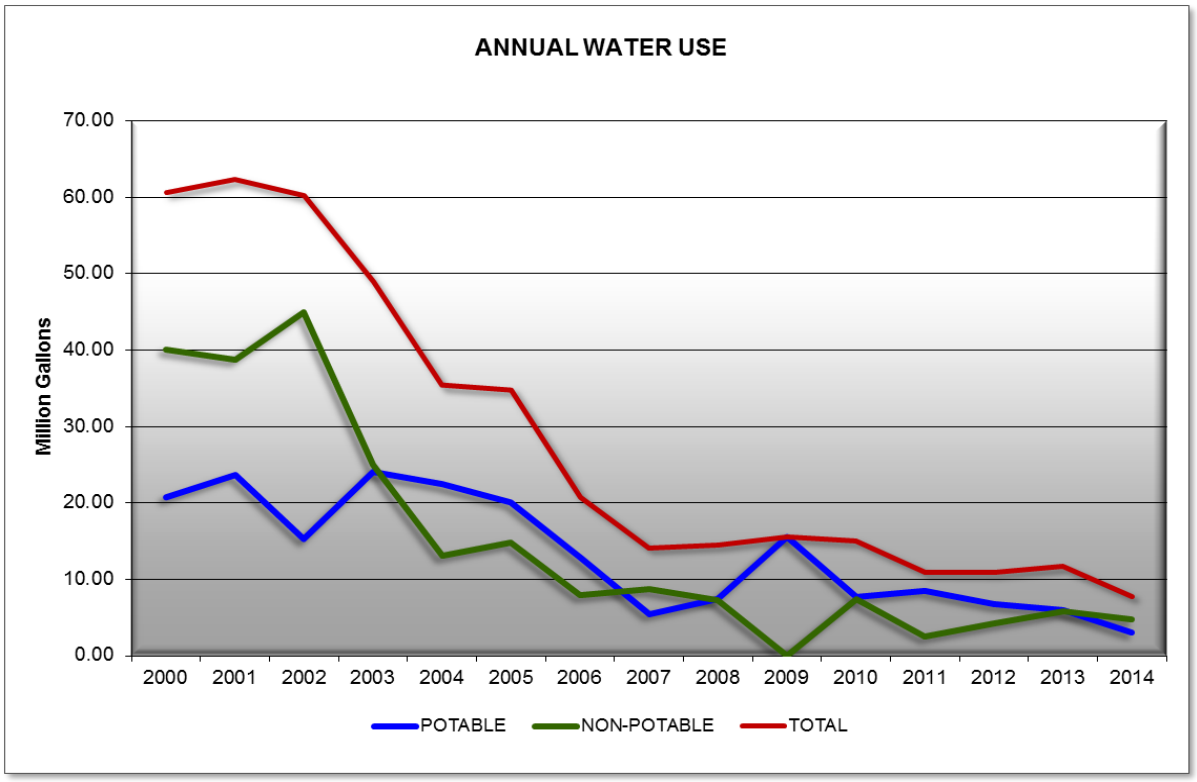

Figure 10 - Annual water use, FY2000–2014, showing both potable and process water.

Planned Actions:

PPPL's main cooling tower is inefficient when compared to today's technology. This cooling tower is nearly 30 years old and requires regular repairs to maintain operations. It represents a single point of failure in PPPL's cooling water systems. Replacement of the central cooling tower is one of the few remaining water conservation projects with significant water savings potential. PPPL's GPP program has identified a replacement high-efficiency cooling tower as a necessary site investment, but limited GPP funding has precluded initiation of the project in order to execute other critical infrastructure repairs or replacements. Replacement of the existing cooling tower and the eventual installation of a second parallel tower are including in PPPL's Campus Modernization Plan.

2.4.3 Water Metering

In conjunction with ongoing energy metering efforts and HPSB building evaluations, PPPL will continue to install standard building or process water meters for both potable and industrial water and will connect them to its site-wide building BAS to the maximum extent practical. During FY12 water meters were installed in four buildings bringing the number of separately metered buildings to five. The potable water survey mentioned above will further identify locations that are best suitable to increase the number of metered buildings.

Surveys were performed in FY2014 throughout the site to identify potential locations for future water meters. One of these identified locations received a new meter in FY2014 and this meter was added to PPPL's BAS for visibility and tracking.

2.5 Goal #5: Pollution Prevention and Waste Reduction

This section discusses the pollution prevention (P2) programs and waste reduction efforts to meet the goals contained in EO13423, EO13514, and the DOE SSPP. These goals include the recycling of at least 50% of municipal solid waste (MSW) and non-hazardous, non-contaminated construction and demolition (C&D) materials and debris by FY2015 and to increase the diversion of compostable waste and organic material from the waste stream. In addition, PPPL strives to identify and implement sustainable pollution prevention best practices and to reduce use of toxic, hazardous, and GHG-emissions contributing chemicals that are acquired, used or disposed of through source reduction, the use of acceptable alternative chemicals and processes, and recycling. Over the past five years, PPPL has maintained average recycling rates for MSW and C&D waste streams of 67% and 85.5%, respectively. The combined recycling rate by weight for the MSW and C&D waste streams was 80.4% for FY2014.

2.5.1 Solid Waste Diversion

Performance Status:

Solid waste data, including construction, composting, and recycling is reported annually in DOE's CEDR. PPPL continues to exceed the FY2015 goal of a 50% recycling rate for both MSW and C&D waste by achieving recycling rates of 77.9% and 84.1%, respectively in these categories for FY2014 (see Figures 11 and 12, below). The red lines in these graphs represent the DOE waste diversion goal of 50%.

Municipal solid waste trash totaling 24.1 tons was collected at PPPL and transported to a permitted solid waste landfill for disposal. PPPL has a mature and effective waste minimization and recycling program that limits the amount of waste disposed in landfills. PPPL's waste subcontractor participates in a single stream recycling program, which has increased our recycling diversion implementation at PPPL. PPPL has incorporated recycling and sustainability requirements into appropriate subcontracts. In FY2014 PPPL diverted 77.9% of the municipal solid waste generated at the site from landfill disposal.

In FY2014 PPPL continued to expand its food/compostable waste composting program collecting compostable waste from the site cafeteria and satellite locations for off-site processing. Our cafeteria vendor has embraced the composting program by supplying compostable food service items and establishing practices that minimize waste disposal, as specified in our cafeteria SOW. PPPL's third full fiscal year of composting has yielded over 20.7 tons of recycled compost, an increase of 26% from FY2013.

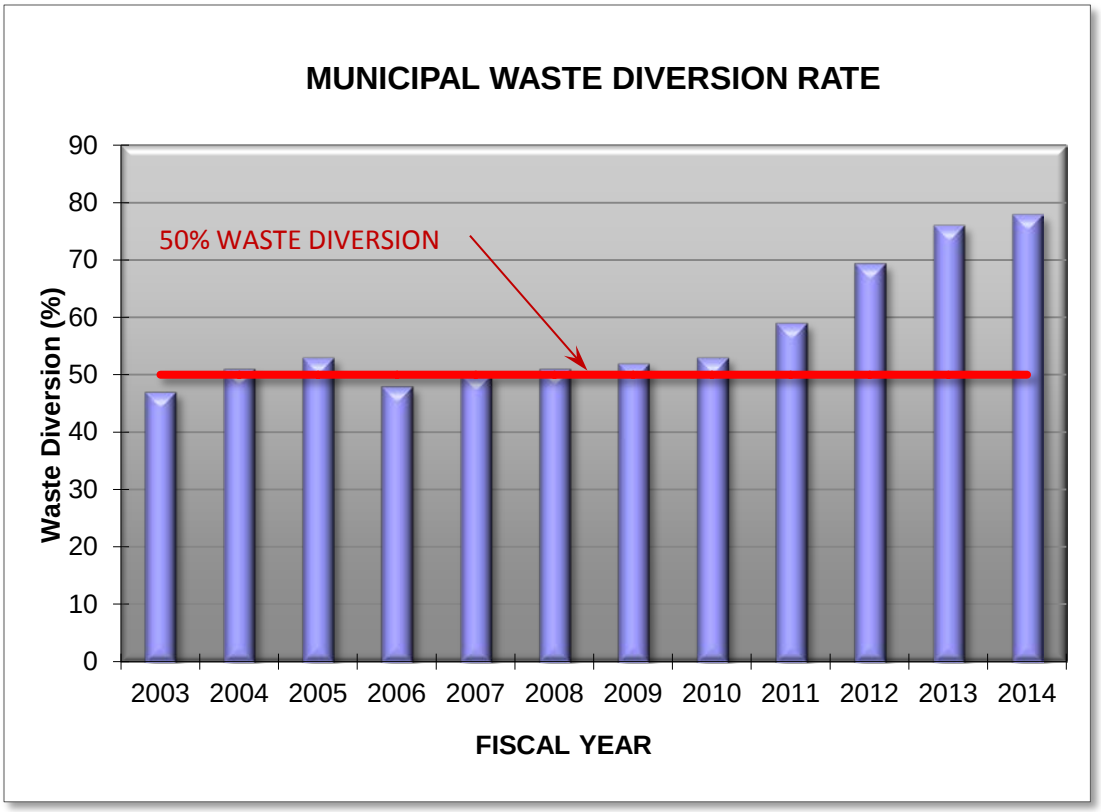

Figure 11 – Annual MSW recycling rate, FY2003-2014.

Pollution Prevention & Waste Minimization Activities:

In order to control the quantity of toxic/hazardous chemicals brought on-site, all chemicals and items which could have an adverse effect on safety, health, or the environment, including those brought on site by subcontractors, are evaluated by Industrial Hygiene (IH) personnel of the Environment, Safety, Health and Security Department (ESH&S). IH also reviews proposed chemical purchases against a listing of environmentally sensitive chemicals. IH and/or ESD personnel recommend substitute products or processes for less hazardous substitute materials when appropriate.

The preferred method of disposing of hazardous and universal waste at PPPL is through recycling. One hundred percent (100%) of recyclable hazardous and universal wastes generated at PPPL are sent off site for recycling or treatment. This includes all mercury waste, lead-acid batteries, NiCad batteries, capacitors (PCB and Non-PCB), and lighting ballasts. In FY2014 PPPL recycled 18,934 pounds of ballasts, bulbs and batteries and diverted 14,704 pounds of hazardous waste via incineration.

PPPL's subcontracted pest management service has implemented integrated pest management (IPM) practices through its written IPM Plan. To the maximum extent practicable, chemical pesticides are minimized and animal-friendly capture and off-site release is used to remove unwanted animals. The interior application of pesticides is carefully controlled and minimized so as not to affect indoor air quality and to minimize potential employee exposure.

PPPL encourages sustainable acquisition through various purchases including 30% post-consumer recycled content in general use copy paper through the lab-wide office supply. PPPL encourages double sided printing and recently updated our printing servers to include default duplex printing for Windows users on 122 out of 137 duplex capable printer's lab wide. PPPL decreased its paper purchases by 41% from FY2010 to FY2014, much of which can be contributed to duplex printing and the increasing use of wireless tablet computers.

PPPL has maintained and expanded its single stream recycling and organic/food waste composting program. In FY2014 PPPL conducted a site audit of PPPL's single stream Municipal Recycling Facility (MRF) to ensure items recycled offsite are indeed sorted and sent for recycling. In addition, opportunities to reuse on-site, excess and/or recycle unneeded materials and equipment will continue to be identified and acted upon. PPPL will also continue its practice of carefully screening chemical purchases and will continue to identify and act upon opportunities to pilot test products that are less toxic, non-hazardous or biobased as substitutes for current chemical products.

2.5.2 Construction & Demolition (C&D) Waste Diversion

PPPL will continue to maximize the recycling of C&D waste and should continue to meet or exceed the 50% goal. PPPL achieved a C&D waste diversion rate of 84.1% in FY2014.. For many years, PPPL has recycled concrete, asphalt, wood, roofing ballast, scrap and other building materials into out C&D diverted waste stream. In addition, subcontracts for construction and facility renovation services will include provisions to maximize recycling. Recycling contracts are in place for many waste streams (i.e., electronics, scrap metal, wood, paper, plastic, glass, tin, etc.) and all recycling data are reported in the CEDR.

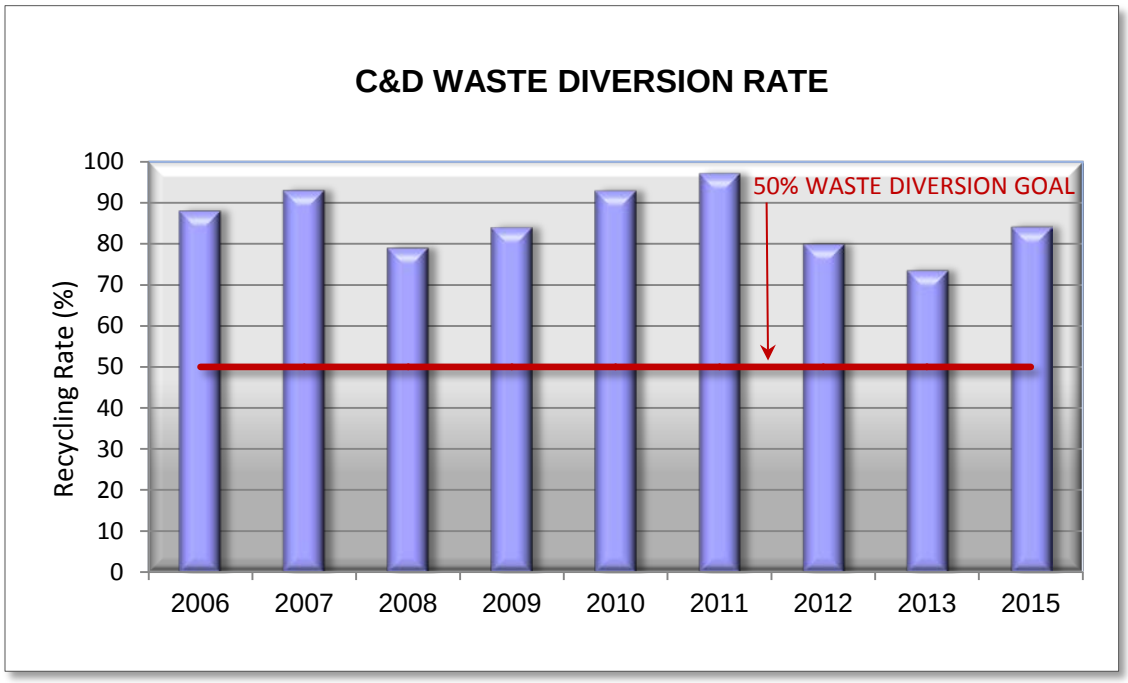

Figure 12 – Annual C&D recycling rate, FY2006-2014.

2.6 Goal #6: Sustainable Acquisition

2.6.1 Subcontractor Sustainability Goal

DOE's and PPPL's goals in Sustainable Acquisition is to ensure that 95% of new contract actions, including task and delivery orders under new contracts and existing contracts, require the supply or use of products and services that are energy efficient (ENERGY STAR® or FEMP-designated), water efficient, biobased, environmentally preferable (including EPEAT-registered products), non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives.

PPPL earned DOE's Gold GreenBuy Award for the purchasing of products with minimal environmental impacts in FY11 and FY12. Actions to improve the management of chemicals have been underway for years (e.g., inventory management, redistribution of excess chemicals, and improved lifecycle chemical use planning). PPPL continues to utilize bulk biobased cleaners for all cleaning purchases. The use of bulk supplies also reduces the MSW stream by minimizing packaging. On many applicable building construction contracts, PPPL requires the use of USDA bio-based materials or references the use of ASTM E2432-11, a standard guide for general principles of sustainability relative to buildings. Additionally, many construction contracts ordain that waste is properly recycled or disposed.

Performance Status:

PPPL's standard subcontract document Representative and Certifications Booklet includes the required sustainability clauses for federal acquisition of sustainable products and services. PPPL's Environmentally Preferable Purchasing policy (P-082) encourages all employees to identify and specific suitable environmentally preferable products. Targeted contracts and/or purchase specifications contain standard requirements for ENERGY STAR®, WaterSense®, biobased, and recycled or non-toxic products. PPPL's procedure for preparation, review, and approval of specifications and statements of work (ENG-006) was recently amended to also include sustainable acquisitions for pertinent work.

As applicable, vendors are required to report EPP purchasing data for inclusion in the Laboratory's CEDR submittals. In FY2014 PPPL's Environmental Services Division launched a green purchasing webpage to help employees facilitate sustainable procurement of products. Examples include the paperless on-line office supply system that automatically directs users to recycled, remanufactured, and other "green" products, a standard specification for EPEAT-qualified electronics, and the exclusive use of recycled and biobased janitorial supplies. In addition, PPPL's Facilities Division has standardized its specifications to use an extensive array of energy efficient and sustainable building and maintenance products including solid-state LED and low-mercury lighting, recycled content carpeting and ceiling tiles, and the use of ultra-low VOC paints and adhesives.

PPPL's Environmentally Preferable Purchasing policy (P-082) identifies a broad range of environmentally preferable products and outlines responsibilities to promote sustainable acquisition. It encourages all employees to identify and specify suitable environmentally preferable products in the course of their work. Procedure ENG-006 ensures that PPPL

employees who write specifications or statements of work will ascertain if sustainable acquisition or sustainable design practices are applicable, and include them into the contract language as they are needed. An Environmentally Preferable Purchasing web page was developed to provide a convenient green product and services reference for employees. Existing Federal products guidance and listings are being linked to this page.

PPPL's P-Card purchasing system (credit card orders) is used when the dollar amount for the acquisition is less than $3,000. These transactions represent a large portion of the lab's purchases. To ensure that all of PPPL's acquisitions are reviewed for potential sustainable initiatives, the system was modified to include a sustainability review check box. This function allows P-Card holders to review if their procurement needs to meet sustainable requirements, when the box is finally checked a message is sent to sustainability specialists whom will provide further guidance to the purchaser.

Planned Actions:

PPPL will continue reviewing its procurement process to identify suitable contracts for inclusion of the requirement for products and services that are energy efficient (ENERGY STAR® or FEMP-designated), water efficient, biobased, environmentally preferable (including EPEAT-registered products), non-ozone depleting, contain recycled content, or are non-toxic or less toxic alternatives. We will also continue to review and update applicable specification and purchasing guidelines to specify that applicable Federally-mandated designated products and services are included in relevant acquisitions and will identify opportunities to further strengthen implementation of the requirement for federally-mandated designated products in purchasing programs as appropriate.

2.7 Goal #7: Electronics Stewardship and Data Centers

2.7.1 Data Center Metering

Performance Status

Advanced electric meters to measure a monthly PUE have been installed at the main data center, known as the Plasma Physics Laboratory Computing Center (PPLCC). This allows an exact calculation of PUE for this facility.

Planned Actions

The PPPL Computer Center (PPLCC) is the only area considered a data centers per DOE's definition of a data center published in the SSP Guidance of 2012. Experimental control computers were permanently relocated into the PPLCC in FY2014. Advanced power meters to measure monthly PUE were installed in the PPLCC in September 2013.

2.7.2 Data Center Power Utilization Efficiency (PUE)

Performance Status:

Data Center Improvements: PPPL has completed the process of permanently relocating experimental control computers and associated equipment from the Fusion Control Center (FCC) consolidating them into a single data center in the PPLCC. The annual average PUE for the PPLCC in FY2014 was 1.55.

During the past few years, several information technology (IT) hardware improvements were implemented to reduce energy consumption and in some cases reduce the cooling demand of the IT equipment. Windows servers continue to be consolidated into a virtualized blade environment. PPPL is currently running 22 virtual machines with an estimated power savings of 360 watts per machine or 7.92 kW. 21 UNIX servers were consolidated into 3 high availability servers, saving approximately 2 kW/hr of electricity. A further consolidation is underway to move the services of ~15 servers in to a single high availability cluster of 3 systems, reducing server count by 12. PPPL's Facilities Division installed a hot aisle containment system in rows H & I of the data center to direct the exhaust air from these servers directly back to the air conditioning units and reduce hot/cold air mixing in the room. An underfloor baffle was installed to direct cold air directly to front of rack floor vents. Additionally, diffusers were installed in the floor vents to lower the exit velocity of the cooled air so it would no longer bypass the equipment racks. The raised floor tile has been retrofitted to reduce leakage of air from beneath the tiles to the room.

Implementation of the above actions enabled PPPL to raise the ambient temperature in the room from 67ºF to 74ºF while maintaining appropriate cooling for critical computer equipment. The combined actions provided significant immediate energy savings by reducing cooling load on the existing chillers.

The number of equipment rows in the PPLCC has been reduced by 44%, through consolidation of rows A, B, F, and G into rows C, D, E, F, H, and I. This has allowed floor openings to be closed, improving cool air egress, and reduces the number of racks to be cooled.

Planned Actions:

PPPL is currently evaluating energy efficiency opportunities in the PPLCC to further enhance it energy performance. The migration of EFIT computational systems to a new larger system in the PPLCC has been completed. Consolidation of equipment from row C to the remaining rows D, E, F, H, and I would allow for the installation of additional hot aisle containment. Outside air augmentation and additional air flow control below the floor and above the ceiling would further improve cooling. A long-term project to replace their existing computer room air conditioning ("CRAC") units with a chilled-water cooled system is being considered in conjunction with the Campus Modernization Plan.

2.7.3 Electronics Stewardship

PPPL currently has approximately 950 desktop and laptop computer systems. Approximately 70% are Windows, 20% Macs and 10% Linux. PPPL has established the following goals to meet sound electronic stewardship and management of data centers.

- Reduce the energy consumed by computing resources through equipment upgrades, employee outreach/education, and the appropriate use of network power management solutions.
- Maintain environmentally-sound practices for disposition of all excess or surplus electronic materials.
- Continue efforts to reduce the energy consumption of the PPPL data center (PPLCC).

Performance Status

PPPL presently uses Windows Group Policy to control the power management settings on monitors attached to Windows systems. After 20 minutes of inactivity, monitors enter sleep mode. This is a hard setting that cannot be changed by users. With Windows XP being retired, and a new version of Mac OS X, additional management settings are being investigated.

A centralized print server has been deployed which configures printers to use the duplex feature by default. Printers on this server are also set to enter power saving mode when possible. Users are encouraged to take advantage of the printers on the print server rather than individual printers.

PPPL strives for 100% EPEAT compliance when purchasing new desktop and laptop computers. When this is not possible, special approval must be obtained. Users are required to submit substantial evidence to obtain approval to purchase a device that is not EPEAT compliant.

PPPL is also encouraging users to replace traditional desktop systems with thin client devices, which consume less power, whenever possible. Two types are presently offered - a Windows variant and a Linux solution.

PPPL has lab-wide policies to manage excess or surplus electronic products in an environmentally-responsible manner. Best practices to manage equipment that meets PPPL requirements and is still usable are:

- Redeployed within PPPL to other staff,
- Listed for reutilization/transfer to other DOE facilities in Federal Disposal System/Energy Asset Disposal System (FEDS/EADS),
- Listed for reutilization/donation to Used Energy-Related Equipment (ERLE) & Computers for Learning (CFL) programs in FEDS/EADS,
- Listed for reutilization/transfer to federal agencies in FEDS/EADS,
- Listed for reutilization/donation to state agencies in FEDS/EADS,
- Offered for sale by GSA sales, and

- Unsold items are boxed and shipped to UNICOR, a certified e-waste recycler.

Planned Actions

Three paths are being considered to promote power management:

1. PPPL routinely reviews and updates its power management settings for desktop and laptops. Newer version of the Windows and Macintosh operating systems allow greater flexibility in power management. These settings are actively being investigated and are targeted for launch in FY2015.

2. PPPL will also continue to deploy thin clients rather than traditional workstations where appropriate.

3. Greater emphasis will also be placed on promoting the use of power management where applicable. The use of personal printers will continue to be discouraged. Users will also be encouraged to consolidate multiple systems into single systems where applicable.

Barriers:

Power management methods interfere with security practices at PPPL. These include but are not limited to operating system and software updates, virus scans and definition updates, backups and general functioning.

Additional challenges are met with older hardware that does not play well with modern power management software. Although measures are being taken to eliminate this hardware, it still exists in small quantities.

Although PPPL offers two types of thin clients, user acceptance has proven to be very challenging. It is estimated that as many as 60% of employees could be moved off of traditional desktops to thin client devices. However, many feel that their experience is more limited when using a thin client and resist this option.

2.8 Goal #8: Renewable Energy

2.8.1 Renewable Energy

Under EPACT05 and EO13423, DOE facilities are required to have 7.5% of their electricity consumption from renewable energy sources by FY 2013 and are encouraged to have on-site renewable energy installations.

Performance Status:

PPPL and the DOE Princeton Site Office (PSO) have pursued renewable energy projects for several years, engaging the Federal Energy Management Program (FEMP) and the National

Renewable Energy Laboratory (NREL) to conduct feasibility studies for a large-scale photovoltaic solar power installation. The latest NREL feasibility study was updated in October 2008 to address current New Jersey energy market conditions and on-site technical considerations.

In 2007 Constellation Energy visited PPPL as part of DOE Mid-Atlantic Super Energy Savings Performance Contract (ESPC) program to evaluate potential projects for inclusion in an ESPC at the site. Their Initial Proposal was received in December 2007. It identified five Energy Conservation Measures (ECMs) including a 1.16 MW solar photovoltaic project. After careful consideration of the ECMs and financial considerations, DOE and PPPL agreed that the proposed ESPC would require significant up-front investment and was not financially justifiable. PPPL has continued to pursue ECMs identified by the Laboratory prior to and during the ESPC process where they are cost effective as funding permits.

In 2009 and 2010 PPPL and DOE-PSO engaged the Defense Energy Support Center (DESC) and Federal Energy Management Program (FEMP) to pursue a potential on-site photovoltaic (PV) renewable electricity project through a long-term power purchase agreement (PPA). Tax credits, state rebates, solar renewable energy certificates (SRECs) and other economic incentives that contribute substantially to the financial success of PVs are not available to DOE and Princeton University, but could contribute to a third party-financed project. A Request for Proposal (RFP) for installation and operation of a 1.0 MW PV through a PPA was issued in early 2009. A final cost proposal for the project was received in early calendar year 2010. Evaluation of the final cost proposal by DESC, DOE, and PPPL determined that a large-scale solar photovoltaic project was not financially viable due to several constraints including the property lease duration for the PPPL site, the financial risks associated with solar energy credits, and a 10-year statutory limit on PPAs. The unit price for electricity through the PPA would be more than three times what PPPL was paying in early 2010. DOE terminated the PPA process in March 2010 because it was not financially viable. PPPL's Comprehensive Energy Data Report (CEDR) submittal includes a 1.0MW or larger solar PV project proposal that would meet or exceed the statutory requirement for 7.5% renewable electrical energy, should funding for such projects become available.

PPPL purchased 1,548,000 KWH Renewable Energy Credits from Renewable Choice Energy accounting for 7.5% of total electrical energy used at PPPL during FY14. This purchase satisfies the 7.5% renewable electrical energy requirement.

Planned Actions:

PPPL presently has no plans for large-scale on-site renewable energy projects. PPPL will continue to monitor the development of building-integrated and other renewable energy technologies and incorporate them into ongoing energy efficiency efforts as existing programmatic funding permits.

Barriers:

The land on which PPPL resides is leased from Princeton University until 2026. DOE has determined that any third-party financing agreement (ESPC, PPA, etc.) for the installation and operation of renewable energy systems would be limited to the time left on that lease and not the standard 25 year period. Assuming a one year construction period for a renewable energy

system, that time period is further reduced. Such a limited payback period makes such projects financially unattractive for both investors and for DOE. Current levels of GPP infrastructure funding are insufficient to meet documented programmatic needs and support any substantive renewable energy investments.

2.9 Goal #9: Climate Change Resilience

As a relatively small facility located in Central New Jersey, climate change represents a fairly limited direct risk to the PPPL facility. PPPL has completed the DOE vulnerability assessment survey addressing and location-specific risks of climate change, and has identified on-site and nearby impacts of recent severe weather events that have impacted the Central New Jersey region. We have also identified how the Laboratory used these experiences to identify risks posed by severe weather events and adapt its emergency planning and communications processes to enable better preparations and response.

The 2014 National Climate Assessment identified a number of anticipated climate change impacts for the Northeastern United States, including New Jersey. They include:

- Heat waves, coastal flooding and river/inland flooding will increasingly impact the region's environmental, social and economic systems.
- Infrastructure will be increasingly compromised by heat, cold, flooding and other severe weather events.
- The adaptive capacity of regional ecosystems will be increasingly compromised with the increased frequency and intensity of severe weather events.

Regional climate change impacts relevant to PPPL include:

- Operational and budget impacts due to magnified water and energy/electricity shortages, greater energy price fluctuations and/or prolonged droughts,
- Damage to facility infrastructure or operational disruptions due to flooding or other extreme weather events,
- Operational constraints due to increased temperatures, as well as supply chain and energy disruptions,
- Workforce issues due to heat, health, quality of life, and cost of living,
- Reduced operational efficiency, increased costs and other operational constraints, disruptions, and/or delays due to regional and international impacts, and
- New mission opportunities, both domestic and international to enhance U.S. climate change resilience and ensure U.S. energy and economic security.

Severe weather events are increasingly likely as a result of global climate change. Potential direct impacts from such events may include more frequent strong storms. The existing site storm water infrastructure may need improvement or reconfiguration to accommodate such storms. Waterways and wetlands adjacent to the site may be subject to more frequent and more severe flooding. Some buildings and infrastructure near these features have been identified for potential relocation to other parts of the site. Capital projects to support such relocations were previously identified for other purposes, however funding for the relocations has not been

identified. Increased hot and cold weather extremes will impact the site's energy use profile, potentially resulting in increased GHG emissions from the added heating and cooling loads. The Campus Modernization Plan includes facility and infrastructure investments to enable future scientific missions. The Plan is expected to be updated and revised regularly to reflect changes to Laboratory mission other development. Potential direct climate impacts will be considered in future revisions to the Plan.

The disruption of energy supplies, materials, subcontracted services, and the displacement of employees are potential indirect risks to Laboratory operations. Recent operating experience, especially hurricanes Irene (2011) and Sandy (2012), indicates that such severe weather events will likely affect regional infrastructure, such as roads and bridges, even if the Laboratory is not directly impacted. Regional damage will likely impact employee's ability to report for work, may result in extended power and/or water outages, and may result in fuel and other supply chain shortages. Such disruptions could result in reduced Laboratory operations and a resulting impact to its scientific mission. In response to recent severe weather events, PPPL's emergency planning and response process has been strengthened to include a range of anticipated severe weather events. Key Laboratory organizations, including facilities, experimental operations, engineering, safety, and security participate in pre-event planning meetings and post-event debriefings.

PPPL is participating in the DOE Climate Change Adaptation Working Group and is engaged the developing state climate change adaptation efforts led by Rutgers University and will continue to participate in this effort as appropriate to Laboratory planning and operations. The Laboratory has not assigned climate change adaptation planning to any individual or organization. It is a subject of consideration for our Environmental Review Committee and ES&H Executive Board.

2.10 Goal #10: Energy Performance Contracts

As discussed in Section 2.8.1, PPPL has pursued on-site renewable power projects of approximately 1 MW in size through both Energy Savings Performance Contract (ESPC) and Power Purchase Agreement (PPA) processes. These projects were found not to be financially viable. While not successful in bringing on-site power generation to PPPL, they identified key institutional, policy and statutory barriers to implementation. PPPL will continue to purse smaller scale renewable power systems where suitable and where infrastructure funding is available. We will continue to evaluate alternative financing options, such as combined ESPC-PPA or Utility Energy Service Contract (UESC) options for financial viability under continued budget constraints.

The PPPL Campus Modernization Plan, published in July 2014, supports this goal while addressing aging infrastructure and modernizing existing space with investment in site design and building development that maximizes energy efficiency and renewable energy opportunities. Throughout FY2015, PPPL plans to where possible design and initiate plans for high performance, low-energy consuming facilities through a variety of financing mechanisms that help minimize PPPL's energy footprint while accommodating campus growth. PPPL's planned actions include the identification and implementation of energy efficiency projects that are lifecycle cost effective in order to continue to reduce the energy intensity of its operations and

that may be candidates for a bundled energy performance or utility service contract including renewable energy and energy efficiency projects.

3. Fleet Management

As directed by the Office of Science (SC) in supplemental guidance, a narrative addressing the Fleet Management section of the SSP is not included as a separate section. The fleet-related goals are addressed in Section 2, Goal 3 (Section 2.3), above.

4. Funding

PPPL has funded sustainability projects to-date with existing programmatic overhead funds, including GPP and OPEX funding. Examples of these projects include lighting and other energy efficiency improvements, cool roof installation, green building renovations, boiler efficiency improvements and enhanced management of fugitive SF_6. Sustainability projects are evaluated annually by a technical review committee along with other proposed GPP- and OPEX-funded facilities and experimental projects. All projects are prioritized using the same CAMP evaluation system. We have identified significant opportunities for improvement in our CEDR submittals that are not currently funded. Completion of additional sustainability projects is subject to availability of funding and competing operational priorities, such as safety and corrective maintenance needs. The current and continuing funding challenges, has required PPPL to look toward new and different methods for conserving energy and reducing utility costs; therefore, executing a strategic energy management program is essential. PPPL's Energy Management Plan will provide a roadmap to achieve our goals. This plan is currently in development and will be finalized in FY2015.

Summary of Sustainability Project Funding ($K)

Category	FY14 Actual	FY15 Planned	FY15 Projected	FY16 Projected
Sustainability Projects	0	TBD	TBD	TBD
ESPC/UESC Contract Payments (if applicable)	0	0	0	0
Renewable Energy Credits (REC) Costs	1.86	3.20	3.07	5.52

5. Electrical Energy & Cost Projections including High-Energy Mission-Specific Facilities (HEMSFs)

PPPL's High Energy Mission Specific Facilities (HEMSF) consists of six buildings excluded from the energy intensity goal. These buildings represent 228,000 gross square feet of building space, or 38% of PPPL's overall building footprint, and they house critical experimental devices, including NSTX, and support systems. The list of HEMSF excluded buildings is included in Appendix B. PPPL's magnetic confinement fusion energy research experiments are energy intensive devices, recreating deep space and stellar conditions in the terrestrial environment. This research is PPPL's primary mission and is dedicated to understanding plasma science and technology and developing a carbon-neutral sustainable global energy source for the future. Experimental support systems include critical climate controls (temperature and humidity), ventilation (safety-related), power storage/distribution (motor-generators), high-voltage power conditioning systems, neutral beam heating systems, as well as critical experimental magnet, cryogenic, and vacuum systems. In addition to extensive experimental operation and support systems, the HEMSF also includes mission-critical experimental data collection on control systems.

PPPL has submitted a waiver from the energy intensity reduction goals for these experimental facilities, but continues to develop and evaluate energy efficiency improvements that can be implemented in these areas. These projects will continue to be considered for implementation under our GPP and OPEX programs. PPPL's CEDR submittal identifies numerous potential energy efficiency projects for experimental systems that do not currently have funding available. Past projects in these areas that were completed with budgeted operating funds include lighting replacement in the former TFTR Test Cell, steam and condensate pipe replacement, and ongoing HVAC equipment optimization efforts. In addition, changes in the operation of certain experimental power and support systems have increased the overall efficiency of PPPL's experimental systems. Finally, if PPPL is selected as the site for testing CS magnets for the ITER project, the 1970s-vintage 1,040W liquid helium refrigeration system will be targeted for replacement. The new refrigeration system would be significantly more energy efficient and would enable more efficient experimental operations.

Experimental systems in these buildings and the supporting infrastructure are not separately metered for electricity, steam, chilled water, etc. The configuration of these systems will not enable separate experimental metering without cost-prohibitive system modifications.

PPPL's primary experiment, the National Spherical Torus Experiment (NSTX) is currently completing an upgrade to double the neutral beam heating capacity, the plasma current and the torroidal magnetic fields as well as extending the experimental pulse length. The overall electrical power consumption for NSTX-U is expected to be comparable to NSTX operations. This is due to a longer duration between experimental pulses under the new operating regime compared to current operations. Experimental electricity use during the period FY2012 through FY2014 is also expected to be lower than normal, but will rebound to approximately FY2010 levels when NSTX-U begins operations. It should also be noted that experimental energy use is significantly affected by the level of funding provided for operations. Our projections are based on a typical annual experimental run period of approximately 16 weeks. If experimental

operations are expanded or reduce or significant experimental missions are added, energy use will change accordingly. Table 4, below, provides a summary of actual and projected HEMSF electricity use for FY2011 through FY2020. The projected HEMSF electricity use includes both the experimental systems and supporting D-Site infrastructure.

Table 4 – Summary of actual and projected HEMSF electricity use (MWh/yr), FY13-FY20

	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20
HEMSF D-Site	4,108	4,108	4,108	4,108	4,108	4,108	4,108	4,108
HEMSF NSTX-U	7,254	7,496	14,177	18,659	18,659	18,659	18,659	18,659
Site Base	9,177	9,089	9,300	9,300	9,300	9,300	9,300	9,300
Total	20,449	20,603	27,495	31,977	31,977	31,977	31,977	31,977

Ongoing and planned energy efficiency improvements associated with lighting, HVAC, and other support infrastructure will continue to be implemented where lifecycle cost effective and as funding permits. These projects will contribute to the Laboratory's overall energy efficiency profile and enhance the efficiency of experimental operations.

The primary utility cost at PPPL is for electricity to support experimental and facility operations. Electricity represents approximately 90% of PPPL's total utility costs. Natural gas and water represent the remaining 10% (see Figures 13 and 14, below). Actual and projected electricity costs are shown in Figure 15. Projected annual electricity costs are based on projected electrical use discussed in Section 6, above, and the average annual unit cost of electricity from 2008 to 2014. Since New Jersey is a deregulated electricity market, the unit cost of electricity fluctuates. Actual future electricity costs many vary considerable from these projections based on market conditions.

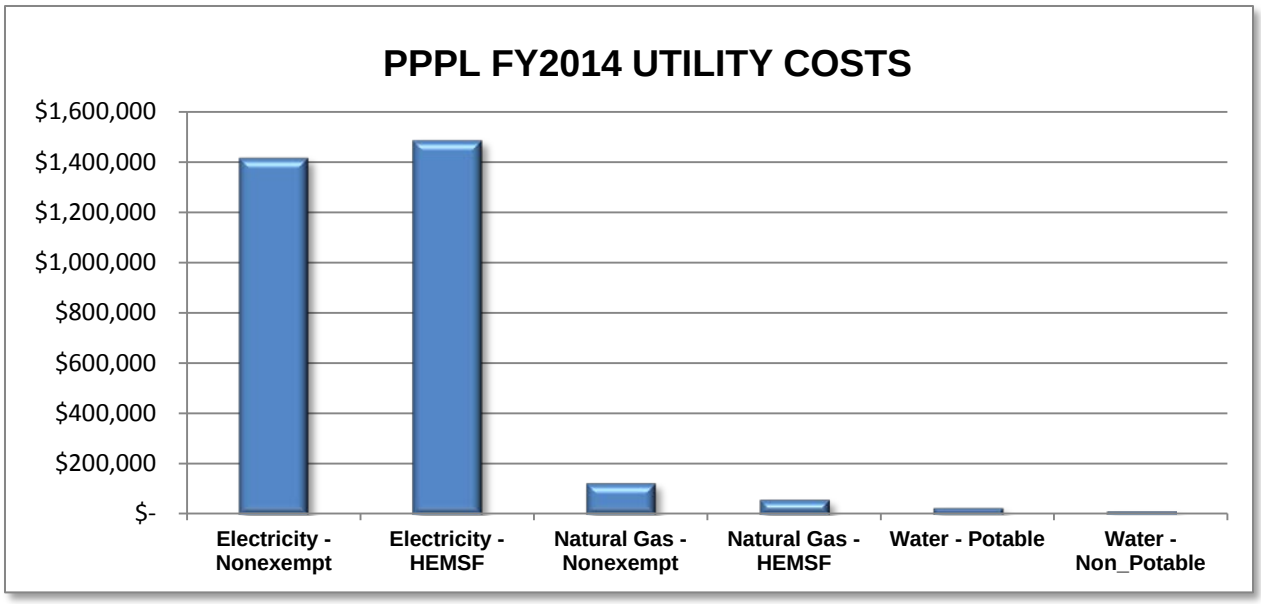

Figure 13 - PPPL utility costs for FY2014.

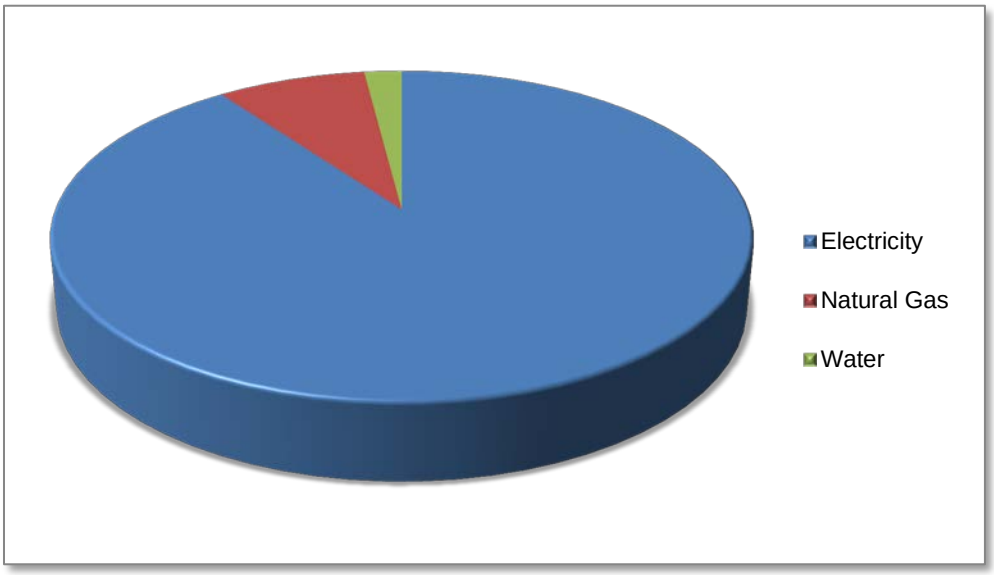

Figure 14 – PPPL FY2014 Utility Costs

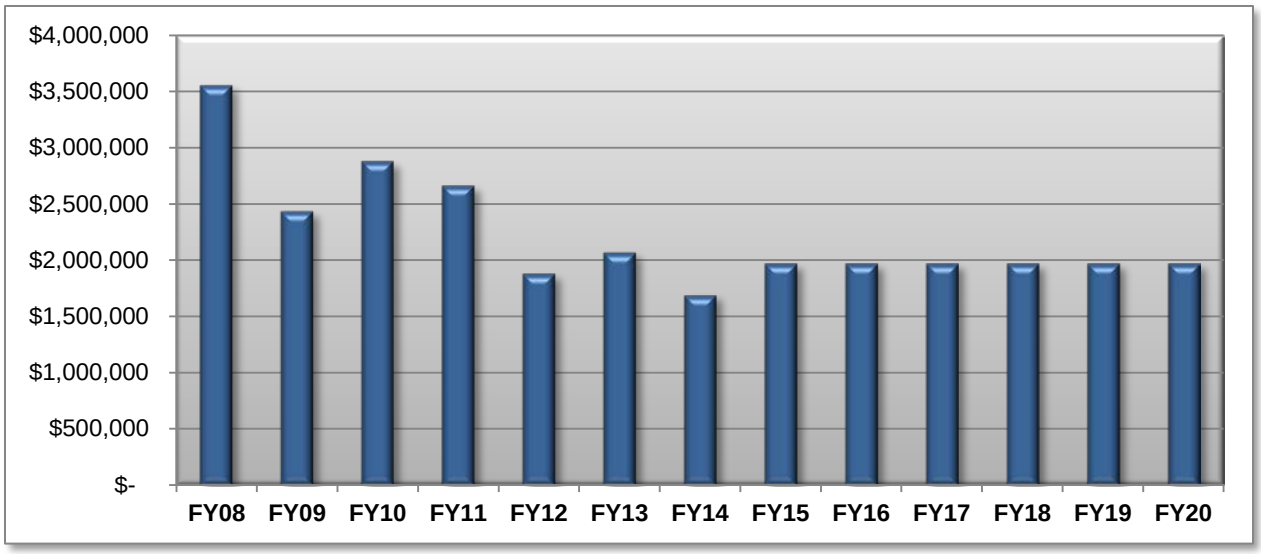

Figure 15 – PPPL Actual and projected electricity costs, FY2008-FY2020.

Actual and projected electricity usage (MWH) for HEMSF (D-Site Experiments), D-Site Non-Experimental and Site Base electricity in the projected electricity usage are shown in Figure 16, below.

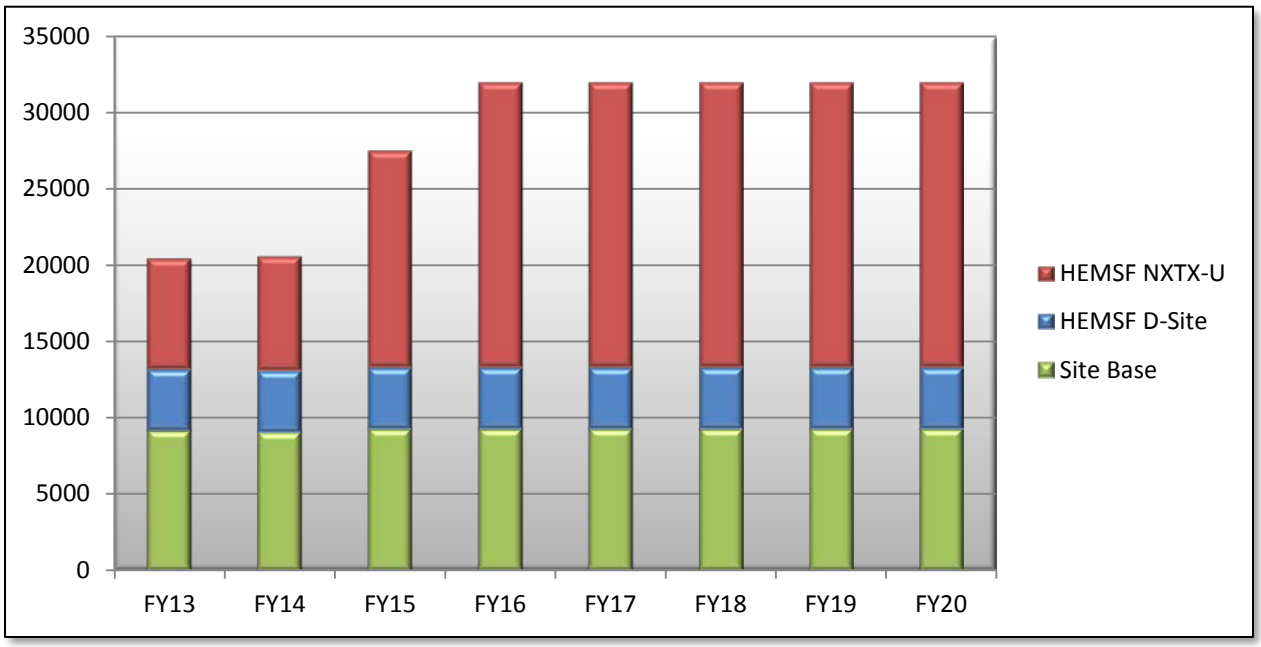

Figure 16 – HEMSF actual and projected electricity usage, FY2013-FY2020.

APPENDIX A – Policy and Program Status Summary Table

Policy and Program Status Summary Table

The table below was provided as Appendix D to *Guidance for FY 2015 DOE Site Sustainability Plans*, dated September 16, 2014 and requested by the Office of Science (SC) in its supplemental guidance dated September 26, 2014.

SSPP Goal – Policy/Program	In Place (Y/N)	Last Update (MM/YY)	Additional Information
Goal 1: Greenhouse Gas Reduction			
Program: Sulfur hexafluoride (SF6) capture	Y	12/14	No SF6 purchased in FY2014
Plan: Commuter reduction	N		
Policy: Teleworking and/or alternative work schedule	Y	12/12	Personnel Practices Manual
Goal 2: Sustainable Buildings			
Policy: Space management	N		
Policy: Cool roof installation	Y		??
Policy: Design new Federal buildings to achieve net-zero energy by FY 2030	N		
Program: Participation in critical local and regional efforts and initiatives	Y		On-going coordination with Princeton Forrestal Center
Plan: Update agency/site policy and guidance (EIS's and EA's)	N/A		
Policy: Dispose and consolidate excess and underutilized property	Y	7/14	Campus Modernization Plan
Policy: Reduce need for new building and field office space	Y		Campus Modernization Plan
Policy: Conserve, rehabilitate, and reuse historic Federal properties	Y		Campus Modernization Plan
Policy: Incorporate sustainable practices into new/renew leases	Y		Campus Modernization Plan
Plan: Green buildings roadmap	Y		Campus Modernization Plan
Program: Sustainable landscape	Y	08/08	Beneficial Landscaping Plan
Plan: Metering	N		
Goal 3: Fleet Management			
Program: Fleet Optimization/Vehicle Allocation Methodology (VAM)	Y		MC – Fleet Procedures
Program: Sustainable transportation options	N		
Program: Vehicle sharing/pooling	Y		
Goal 4: Water Use Efficiency and Management			
Policy: Storm water management	Y	08/12	Stormwater Pollution Prevention Plan
Policy: Water reuse	N		
Plan: Water	N		

SSPP Goal – Policy/Program	In Place (Y/N)	Last Update (MM/YY)	Additional Information
Goal 5: Pollution Prevention and Waste Reduction			
Program: Reduce and minimize hazardous chemicals and materials	Y	11/14	P-014, Waste Minimization
Policy: Integrated pest management and landscape management	Y		Integrated Pest Management Plan
Policy: Increase use of acceptable alternative chemicals and processes	Y	11/14	P-014, Waste Minimization
Policy: Report per Sections (301-313) of EPCRA of 1986	Y		ESHD, Section 8
Policy: Duplex printing and paper containing at least 30% postconsumer fiber	Y	11/14	P-082, Environmentally Preferable Purchasing
Program: Composting	Y	12/14	Ongoing composting and recycling programs in place
Goal 6: Sustainable Acquisition			
Policy: Inclusion of FAR sustainability clause	Y	11/14	P-082, Environmentally Preferable Purchasing; ENG-006, Preparation, review and Approval of Specifications & Statements of Work; Procurement Representations & Certifications
Policy: Inclusion of biobased products	Y	11/14	P-082, Environmentally Preferable Purchasing
Policy: Inclusion of energy efficient products (e.g. Energy Star, FEMP-designated)	Y	11/14	P-082, Environmentally Preferable Purchasing
Policy: Inclusion of recycled content products	Y	11/14	P-082, Environmentally Preferable Purchasing
Policy: Inclusion of water efficient products (e.g. WaterSense)	Y	11/14	P-082, Environmentally Preferable Purchasing
Policy: Inclusion of environmentally preferable products/services (excluding EPEAT)	Y	11/14	P-082, Environmentally Preferable Purchasing
Plan: Environmentally preferable purchasing	Y	11/14	P-082, Environmentally Preferable Purchasing
Goal 7: Electronic Stewardship and Data Centers			
Policy: Power management	Y	01/11	IT-007, Configuration Management
Policy: Data center consolidation	N/A		Data center consolidation completed in FY2014. One data center on-site.
Goal 8: Renewable Energy			

SSPP Goal – Policy/Program	In Place (Y/N)	Last Update (MM/YY)	Additional Information
Policy: Prioritization of on-site renewable	N		
Policy: Purchase renewable energy from sources on tribal land	N		
Goal 9: Climate Change Resilience			
Plan: Update all appropriate plans to address climate change resiliency	N		
Program: Identify or establish and participate in regional climate change programs	Y	12/14	On-going participation in NJ climate adaptation programs through Rutgers University
Goal 10: Energy Performance Contracts			
Policy: Utilize performance contracts	N		
Other			
Program: Cost savings reinvestment	N		

APPENDIX B – List of Excluded HEMSF Buildings from FIMS

Property ID	Property Name	Excluded Facilities (GSF)
00010328	Pppl-Forrestal Campus	
011502CWL	Canal to Water Tower Line	0
031802NSTXSS	NSTX Support Systems	0
031902RP	TFTR Reactor Parts	0
032010	Pedestrian Bridge	0
09246A	Fire Alarm System	0
09246B	Fire Sprinkler System	0
103001STC	Steam Generation & Distribution	0
103001TC	Fuel Storage & Containment Facilities	0
111001SWC	Sewer System	0
140821RD	Roads	0
140821VPAR	Vehicle Parking	0
140821WKS	Sidewalks	0
403030283	Gas Facility (Gasoline Tanks)	0
403030284	D Site Helium/Gas Yard	0
7119030290	D Site Electric Utility	0
7119030291	C Site Electric Utility	0
7119030292	Building Automation System (BAS)	0
7119030299	4 Dry Core Transformer Units East Wing	0
7131030298	C/D Water Utility System	0
7132030301	Mg Free Cooling Ext. Pipe	0
7164030307	Retention Basin	0
802030316	C/D Site Perimeter Fences	0
811030324	Support Structure - ICRF Power to MockUp	0
811030335	Natural Gas Piping	0
C01	Lyman Spitzer Building (LSB)	0
C03	Guardbooth	0
C12	Admin Wing/Cafeteria	0
C13	Admin Bldg/Library/Computer Addition	0
C20	Engineering Wing	0
C21	L-Wing	0
C22	Laboratory Building	0
C23	Theory Wing	0
C32	Shop Building	0
C40	RF Building	0
C41	CS Building, PBX Control Room Passageway	0
C42	COB Building	0
C50	ESAT Building	0
C51	C-Site MG Building	0

C52	PLT Power Building	0
C55	Module 6	0
C60	C-Site Pumphouse (Cool Tower Demolished)	0
C61	Facilities Engineering	0
C64	Material Services Building	0
C67	Emergency Services Building (ESU)	0
C74	Gas Cylinder Storage	0
C90	RESA Building	0
C91	CAS Building	0
C93	Hazmat Storage Building	0
D34	Liquid Effluent Collection Building	0
D35	Rad Waste Handling Facility	6,360
D42	D-Site Experimental Area	87,978
D52	FCPC Building	43,672
D53	NBPC Building	46,204
D70	D-Site Cooling Tower/Pumphouse	4,743
D72	D-Site MG Building	45,420
P1	Canal Pumphouse(offsite)	0
T050	OFFICE TRAILER	0
T051	OFFICE TRAILER	0
TOTAL		**234,377**