BROOKHAVEN NATIONAL LABORATORY

SITE SUSTAINABILITY PLAN

FY 2013

U.S. DEPARTMENT OF ENERGY
Office of Science

BROOKHAVEN NATIONAL LABORATORY

CONTENTS

EXECUTIVE SUMMARY 3

II. PERFORMANCE REVIEW AND PLAN NARRATIVE 13

GOAL 1.1: ENERGY INTENSITY REDUCTION 13
GOAL 1.2: ELECTRIC FROM RENEWABLE SOURCES 16
GOAL 1.3: SF_6 REDUCTION 18
GOAL 1.4: METERING 21
GOAL 1.5: COOL ROOFS 23
GOAL 1.6: TRAINING 24
GOAL 1.7: NET ZERO ENERGY 24
GOAL 1.8: FACILITY ENERGY USE EVALUATION 25
GOAL 1.9: GREENHOUSE GAS REDUCTION, SCOPE 3 26
GOAL 1.10: GREENHOUSE GAS REDUCTION, SCOPE 1 & 2 29
GOAL 2.1.A: EXISTING BUILDINGS 36
GOAL 2.1.B: NEW CONSTRUCTION, RENOVATIONS, AND ALTERATIONS OF BUILDINGS 37
GOAL 2.2: ESPC INITIATIVE, IE, AND THIRD PARTY FINANCING 39
GOAL 2.3: REGIONAL AND LOCAL PLANNING 39
GOAL 3.1: FLEET ALTERNATIVE FUEL CONSUMPTION 43
GOAL 3.2: FLEET PETROLEUM CONSUMPTION REDUCTION 44
GOAL 3.3: ALTERNATIVE FUEL VEHICLES 45
GOAL 3.4: FLEET INVENTORY REDUCTION 46
GOAL 4.1: WATER INTENSITY REDUCTION 47
GOAL 4.2: WATER USE REDUCTION 47
GOAL 5.1: NON-HAZARDOUS SOLID WASTE 56
GOAL 5.2: CONSTRUCTION AND DEMOLITION MATERIAL AND DEBRIS 56
GOAL 6.1: PROCUREMENTS 59
GOAL 7.1: DATA CENTER METERING 59
GOAL 7.2: MAXIMUM ANNUAL WEIGHTED AVERAGE PUE 61
GOAL 7.3: ELECTRONIC STEWARDSHIP 62
GOAL 8.1: AGENCY INNOVATION AND GOVERNMENT-WIDE SUPPORT 63

III. CLIMATE CHANGE ADAPTATION 66

IV. HIGH ENERGY MISSION-SPECIFIC FACILITIES (HEMSF) 66

CENTER FOR FUNCTIONAL NANOMATERIALS 67
NATIONAL SYNCHROTRON LIGHT SOURCE I (NSLS-I) 69
NATIONAL SYNCHROTRON LIGHT SOURCE II (NSLS-II) 70
RELATIVISTIC HEAVY ION COLLIDER (RHIC) 69
HISTORICAL AND PROJECTED ELECTRICITY USAGE WITH HEMSF BREAKDOWN 72

V. BUDGETS AND FUNDING 73

VI. INSPECTOR GENERAL REPORT ON OPPORTUNITIES FOR ENERGY SAVINGS AT DOE FACILITIES 75

APPENDICES **76**

APPENDIX A – ENERGY CONSUMING EXCLUDED BUILDINGS AND TRAILERS LIST 76
APPENDIX B – SUSTAINABILITY HIGHLIGHTS *(OPTIONAL, NOT SUBMITTED)* 76
APPENDIX C – GOAL SUMMARY TABLE 76
APPENDIX D – CONSOLIDATED ENERGY DATA REPORT (CEDR) FOR FY2012 ACTIVITIES *(FILE PROVIDED SEPARATELY)* 76
APPENDIX E – BROOKHAVEN NATIONAL LABORATORY METERING PLAN JULY 2012 UPDATE 76
APPENDIX F – LIST OF ACRONYMS AND ABBREVIATIONS 76

I. EXECUTIVE SUMMARY

Brookhaven National Laboratory (BNL) is operated and managed for the DOE's Office of Science by Brookhaven Science Associates (BSA), a partnership formed by Stony Brook University and Battelle Memorial Institute. For more than 60 years, the Laboratory has played a lead role in the DOE Science and Technology mission and continues to contribute to the DOE missions in the physical, energy, and life sciences, with additional expertise in environmental sciences, energy technologies, and national security. BNL is staffed by roughly 3000 research and support employees, hosting an even greater number of facility users, guest researchers, and scientists. To date, seven Nobel Prizes have been awarded for discoveries made at the Laboratory through nearly 65 years of existence. The Lab operates from an extensive campus located in Upton, New York, on 5320 acres with approximately 4.2 million gross square feet of space in 350 buildings.

With a long-standing expertise in accelerator science and technology, BNL conceptualizes, designs, builds, and operates major scientific facilities and makes them available to university, industry and government researchers, in support of the Office of Science mission. The sustainability vision for BNL leverages this unique combination of access to diverse research talent, stewardship for a significant national research infrastructure, and a location in the energy intensive northeastern United States. As a result, BNL is well established as a northeastern regional resource for sustainability expertise and is effectively utilizing its physical infrastructure for demonstration of sustainability technology. This approach to development and deployment of technology, combining the unique resources of both research and operations, is the vision of the BNL Site Sustainability Plan to help ensure a successful future for our nation.

In addition to efforts in science and technology, BNL continues to be strongly committed to supporting and achieving the targets in the DOE Strategic Sustainability Performance Plan (SSPP) and has made significant progress over the past year.

BNL continues to capitalize on efforts from a strong energy management program that has existed for decades at BNL to achieve substantial reductions in our greenhouse gas (GHG) footprint. Strong relationships with local utility providers has been a business strength of the Laboratory for many years to ensure cost effective power rates for operating the energy intensive user facilities and general infrastructure. BNL continues to collaborate with the local utilities to leverage purchasing power and assist in renewable energy production to jointly support the goals of BNL and the New York region.

On March 1, 2011, BNL began purchasing and receiving 15 mega watts (MW) of hydro power from the New York Power Authority (NYPA). This estimated annual consumption of 120,000 mega watt hours (MWh) of hydropower will result in reducing BNL's GHG emissions by approximately 78,000 $MtCO_2e$ per year. This equates to about 54% of BNL's 2008 GHG baseline and is now included in the CEDR calculations.

As stated in last year's report, BNL's cooperation with the Brookhaven Site Office (BHSO) and a private company, BP Solar International, Inc., in conjunction with a Request for Proposal from the Long Island Power Authority (LIPA) resulted in the construction of the Long Island Solar Farm (LISF) on the BNL site. Construction started in 2010 and commercial operations were initiated with a Commissioning Ceremony on November 18, 2011. The constructed array is made up of 164,312 photovoltaic panels and can produce 32 MW of electricity. It provides clean solar energy equivalent to the power consumption of approximately 4,500 homes on Long Island. Through its role in facilitating and hosting this highly successful project, BNL is helping to avoid - production of 28,000 $MtCO_2e$ GHG. As important and visible as this project is, BNL's commitment to the advancement of solar technology does not end with the LISF. Since the LISF is privately owned and is a production facility, new technologies cannot be tested there. As part of the collaboration to site the LISF at BNL, arrangements have been made for construction of a second, smaller array on site – the Northeast Solar Energy Research Center (NSERC). This 800 kW research array sitting on approximately 8 acres of the laboratory will be a proving ground for BNL and our industrial partners to test new solar system technologies, including electrical inverters, storage devices, and solar modules. This effectively adds solar energy research to the user facility portfolio of BNL. Construction has already started with the clearing of the site and site preparation. This facility is expected to become operational in late 2013.

These projects demonstrate how BNL is continuing to collaborate with many organizations both internally and externally to enhance research at the laboratory with the sustainability goals in mind. BNL staff from the Environment & Life Sciences, Facilities & Operations, and Global and Regional Solutions Directorates, Information Technology Division, and the DOE BHSO has been instrumental in preparing our research agenda, and developing a plan to bring it to fruition. External collaborators already engaged include American Superconductor, Blue Oak Energy, BP Solar, Electric Power Research Institute, General Electric, LIPA, National Renewable Energy Laboratory (NREL), New York State Energy Research and Development Authority (NYSERDA), Stony Brook University, and University of California at San Diego. The DOE Energy Efficiency and Renewable Energy's Solar Energy Technology Program has been instrumental in providing funding for this research as well.

In addition to the above projects and through the Governor's Regional Economic Development Initiative, initial support has been provided for Smarter Electric Grid Research, Development, Demonstration and Deployment Center ($SGRID^3$), a Center that brings Stony Brook University's Advanced Energy Research and Technology Center (AERTC) resources together with Brookhaven National Laboratory (BNL) to create two leading edge facilities that will establish New York as the undisputed leader in "smarter grid" systems design and control and technology development and deployment. Building $SGRID^3$ will provide a laboratory for proving existing technologies and developing needed technologies, and for improving operational effectiveness.

BNL remains committed to complying with the GHG specific targets as well as the other objectives and goals of the DOE SSPP. Substantial progress has been made in the last year on moving the Utility Energy Service Contract (UESC) forward, with tremendous assistance from BHSO. The first task order is anticipated to be awarded in early 2013 and will provide nearly an 8% reduction in energy intensity.

A primary laboratory focus is on building sustainable facilities. Construction of the Interdisciplinary Science Building (ISB I) is due to be completed in early 2013 and is tracking towards LEED Gold. The National Synchrotron Light Source II (NSLS-II) is moving toward LEED certification for the Ring structure with the intent to achieve LEED Silver on the associated laboratory and office buildings.The Renovate Science Laboratories (RSL-II) project is well underway and is expected to attain LEED Silver Commercial Interiors for the work in Buildings 555 and 510.

Utilizing the study performed in 2011, BNL has moved forward with projects to bring existing buildings into compliance with the five guiding principles of HPSB by 2015.This year, design was completed on all Energy Conservation Measures (ECM's) and funding allowed for early construction starts in several buildings. These projects will continue this year.

BNL's construction and demolition recycling rate on concrete remains strong. We continue to store concrete rubble and utilize a subcontract concrete crusher on a batch basis to crush the material into usable product in road bases and parking lot materials.

BNL continues to achieve 100% compliance on environmentally preferred purchases and has achieved 99% compliance on purchase of 30% recycled content paper. The only non-recycled paper purchased is used is for photography and graphics work.

BNL has purchased 100% alternative fuel vehicles (AFV) and therefore exceeded the requirement that mandates 75% of light duty vehicle purchases consist of AVFs. BNL has submitted to DOE the *Right Sizing the Fleet* Management Plan and received early indications that this will be approved. The plan includes exceeding the requirements for percent reductions in non-mission critical fleet reductions. BNL has registered to participate in the Federal Green Challenge and is developing an internal webpage to improve overall employee engagement.

While we believe the GHG reduction target will be achieved, BNL remains somewhat concerned with the impact that facilities growth will have on GHG reduction and water reduction targets. NLSL-II and other High Energy Mission-Specific Facilities will increase our load both in energy consumption, greenhouse gas, and water usage. However, significant progress has been made, with the assistance of BHSO, on moving the UESC project forward. The first phase of work focusing mostly on building features and controls for lighting, steam, heating, and cooling is planned to commence in early 2013. A preliminary feasibility study was completed this year on siting a combined heat and power (CHP) plant for BNL. Initial indications are positive. This year, BNL will invest in a detailed CHP and biomass study to solidify the concept and confirm feasibility to incorporate gasification of local wood waste streams.

Water reduction remains a significant challenge BNL faces moving forward. As noted last year, BNL has already achieved substantial reductions in water usage through the years (about 55% since 1999). When normalized by site growth (building area in gross square feet), BNL's annual water use intensity has decreased from 101 gallons per square foot to 91 gallons per square foot, a 10% water usage reduction from base-year 2007 to present. Most cost-effective water reduction investments have been made. Laboratory growth will tend to increase water use in the future and in fact, NSLS-II could increase the Laboratory water usage by 12%. Economically implementing further water conservation measures will be a significant challenge for BNL as water is plentiful and inexpensive and further water reduction is capital and labor intensive.

Construction is underway for a new groundwater recharge process for the outflow of the site Sewage Treatment Plant. Once completed, this facility will allow BNL to implement a larger groundwater recycle approach.

Construction is underway for a new groundwater recharge process for the outflow of the site Sewage Treatment Plant. Once completed, this facility will allow BNL to implement a larger groundwater recycle approach.

Brookhaven National Laboratory is committed to leadership in sustainability through its management practices, stewardship of the BNL Campus, as well as its research and education programs. The laboratory's efforts in sustainability focus on four broad principles:

1. A strive to be climate neutral through energy use and management,
2. Lowering the environmental impact of the campus through sustainable infrastructure,
3. Leveraging research in conjunction with our operations and in support of the Northeast region, and
4. Fostering a culture of sustainability with our employees and our community.

BNL has formed a senior leadership Steering Group composed of both science and operations that will continue to guide the Laboratory toward these principles.

Sustainability is a major theme for Science, Technology, Engineering and Mathematics (STEM) education at Brookhaven National Laboratory. BNL's Office of Educational Programs continues to develop hands-on learning experiences in sustainable energy sciences and environmental sciences- from elementary students to graduate students. One unique program is called the Open Space Stewardship Program (OSSP), where BNL, local school districts, and relevant land stakeholders partner to conduct research on preserved open spaces to inform stewardship decision making. Other programs focus on alternative energy sources such as biofuels and solar energy resources including the impact of weather conditions on output, and the need for micro-forecasting.

Table 1. Summary Table of Strategic Sustainability Performance Plan Goals, BNL's Performance Status, Planned Actions, and Risks.

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
Goal 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory				
1.1	Reduce energy intensity by 30% by FY 2015 from a FY 2003 baseline.	FY 2003: 323,780 FY 2012: 297,605 % Change: -8.1%	Energy Conservation Measures (UESC) – through use of HVAC setback, efficient chillers, steam charge-back to users and lighting upgrades.	**Medium**
1.2	Achieve 5% annual electricity consumption from renewable sources in FY 2010-2012 and 7.5% by FY 2013 onward.	Renewable energy credits (REC). LISF began operations 11/1/11. 50,646,000 kWh/yr power generated on the BNL site in FY12.	BNL R&D Solar Array at 800+ kW. Will initiate an investment grade feasibility study for a combined heat and power (CHP) facility. Completion of an ongoing wind energy and biomass feasibility study. Continue bio-based fuel for satellite boilers.	**Low**
1.3	SF_6 reduction.	FY 08: 965 FY 12: 1,049 % Change: +8.7%.	1st draft High Energy Equipment Mgmt Plan has been prepared. Final plan targeted for completion in 2nd Qtr FY 2013. Plan is a proactive approach for detecting, preventing and repairing leaks of SF_6 dielectric.	**Low**
1.4	Achieve individual building or process metering for 90% of electricity consumed (by October 1, 2012) and for 90% of steam, natural gas, and chilled water consumed by October 1, 2015.	BNL exceeds targets for metering. See *BNL Metering Plan*.	Advanced steam and water metering to be installed where appropriate.	**Low**
1.5	Install cool roofs when economical for roof replacements. Unless Project has a previous CD-2 approval, new roofs must have thermal resistance of at least R-30.	BNL continues to factor DOE cool roof requirements into all roofing projects. While conformance with ASRAE reflectivity standards is attainable, meeting R-30 insulation value is often not economically viable. In FY 2012, only the	Roofing project managers were reminded of the requirement to evaluate the economic viability for all roofing projects. BNL expects to add the cool roof area of ISB, Building 734 to FIMS in FY 2013. In addition, a 9,000 sf long-beam line addition to Building 740 is being constructed and will have a cool roof.	**Low**

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
		partial re-roofing of 3,100 sf of Building 725 was determined to be economically viable. FIMS was updated to reflect this effort. For new construction, Building 734 (ISB) will meet the cool roof criteria.		
1.6	Training	$27,800 was spent on EP Act 1992 Training in 2012.	International certifications have been obtained by many professionals within the facilities organization. Awaiting further guidelines from DOE on training requirements.	**Low**
1.7	Achieve net zero energy in new or major renovation facilities.	None of the FY 2012 project starts met the criteria for consideration.	A review of the FY 2013 planned projects did not find any projects meeting the criteria to require consideration.	**(Impossible to determine risk since none of the projects met the criterion)**
1.8	Evaluate 25% of 75% of facility energy use over 4-year cycle.	100% of applicable buildings evaluated within the last 4 years.	Facility Condition Assessments and Energy Audits are now combined, reducing costs and ensuring that the 4-year cycle schedule is met.	**Low**
1.9	Reduce Scope 3 GHG by 13% by FY 2020 from a FY 2008 baseline. Reduce employee travel GHG by 12% by FY 2020 from a FY 2008 baseline.	FY 2008: 20,003 FY 2012: 21,996 % Change: +10% As electric loads increase from 2013 – 2016, GHGs from transmission and distribution will rise proportionately. Increases in employee population have contributed to rise in commuting GHGs.	Policy Council supported the establishment of flex work week for non-bargaining nonexempt employees and compressed workweek schedules for non-bargaining employees. Procedures to implement this policy will be developed in Q2 FY 2013. New pilot carpool coop established in Wading River community in November. Pilot will be expanded to several other areas where many BNL employees reside.	**Medium**
1.10	Reduce scopes 1 & 2 GHG by 28% by FY 2010 from a FY 2008 baseline.	FY 2008: 205,542 FY 2012: 138,020 % Change: -32.8% FY 2012 adjusted for LISF: 92,100 % Change: -44.8%.	Hydro Power, LISF, R&D PV Array, combined heat and power (CHP), and REC's to meet RE requirement.	**Low**

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
Goal 2: Buildings HPSB, ESPC Initiative, Regional and Local Planning				
2.1.a	Ensure 15% of existing buildings sized greater than 5,000 gross square feet (GSF) are compliant with the Guiding Principles (GPs) of HPSB by FY 2015.	Energy conservation measure project design completed; Funding enabled early construction starts on several projects.	Completion of several projects: - RTU for B438 - Occupancy sensors in all HPSB Buildings - Night setback controls in B438 and 935 - HPSB improvements in B817.	**Medium**
2.1.b	Ensure that all new construction, major renovations, and alterations of buildings greater than 5,000 GSF comply with the GPs.	No FY 2012 project starts met the criteria for consideration.	A review of the FY 2013 planned projects did not find any projects meeting the criteria to require consideration. BNL will seek CD-0 for the ISB II project in FY 2013; ISB II will be designed to obtain a LEED Gold rating.	**Low**
2.2	ESPC initiative, IE, and third party financing.	UESC Phase I Scope and contract documents completed; ready for RFP.	UESC Phase I to be awarded in FY 2013; UESC Phase II expected in FY 2014.	**Low**
2.3	Regional & Local Planning.	BNL continues to investigate public transportation and increased car-pool ridership. Local renewable energy is supported through the LISF and the NERSC. Natural resource activities include measuring impact of large scale solar installations. Stakeholder involvement includes hosting numerous conferences and routine communications with regulatory and community groups.	Continue to measure ecological impacts of solar installations; continue routine meetings with regulatory and local environmental groups.	**Low**
Goal 3: Fleet Management				
3.1	Achieve a 10% annual increase in fleet alternative fuel	Alternative fueling infrastructure exists for compressed natural gas,	Continue to purchase as many alternative fuel vehicles as possible and remove petroleum	**Low/ Medium**

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
	consumption by FY 2015 relative to a FY 2005 baseline.	diesel, E85, and biodiesel.	vehicles as much as practical.	
3.2	Achieve a 2% annual reduction in fleet petroleum consumption by FY 2020 relative to a FY 2005 baseline.	BNL is reducing petroleum consumption by replacing gasoline and diesel vehicles with alternative fuel vehicles as budgets permit.	Continue to purchase as many alternative fuel vehicles as possible and remove petroleum vehicles as much as practical.	**Low**
3.3	Ensure that 75% of light duty vehicle purchases consist of alternative fuel vehicles (AFV) by FY 2000 and thereafter.	In FY 2012, 100% of light duty vehicles purchased were alternative fuel vehicles.	Continue to purchase 100 % light duty vehicles as alternative fuel vehicles.	**Low**
3.4	Submit the *Right-Sizing the Fleet* Management Plan for approval by Dec. 31, 2012. Identify mission critical/ non-mission critical vehicles by Dec. 31, 2012.	*Right-Sizing the Fleet* Management Plan was developed.	*Right-Sizing the Fleet* Management Plan will be submitted on schedule.	**Low**
Goal 4: Water Use Efficiency and Management				
4.1	Reduce water intensity by 26% by FY 2020 from a FY 2007 baseline.	Water use down 10% since 2007 due to decreased process cooling usage at AGS and elsewhere on site. BNL has focused heavily on water conservation even prior to FY 2007. Water use down 57% since 1999. Final design and site prep for water recharge project in FY 2013.	Continue to practice cost effective water conservation as well as implement the ground water recharge project which will return over 70% of BNL's water usage directly back to the aquifer.	**Medium**
4.2	Reduce water consumption of industrial, landscaping, and agricultural (ILA) water by 20% by FY 2020 from a FY 2010 baseline.	No permanent landscaping or agricultural water use.	None.	**Low**

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
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.	During 2012, BNL's non-hazardous solid waste recycling rate was 57%.	During 2013, we will focus on recycling awareness for new employees, contractors and re-emphasize recycling in computer-based training.	**Low**
5.2	Divert at least 50% of construction and demolition materials and debris by FY 2015.	During 2012, BNL's construction and demolition materials and debris recycling rate was 95%+.	Continue sending C&D materials to the onsite Borrow Pit for consolidation and recycling.	**Low**
Goal 6: Sustainable Acquisition				
6.1	Ensure 95% of procurements each year meet sustainability requirements and include sustainable acquisition clause.	All contract actions for construction and custodial products met sustainable acquisition requirements in FY 2012.	Performance in sustainable acquisition will be documented in the FY 2013 PPTRS reporting system. The requirements for biobased products will be incorporated into BNL's Terms and Conditions in FY 2013.	**Low**
Goal 7: Electronic Stewardship and Data Centers				
7.1	Ensure all data centers are metered to measure a monthly PUE (100% by FY 2015).	Additional meters added in FY 2012; identification of remaining required metering complete.	Installation of remaining metering in FY 2013 and FY 2014.	**Low**
7.2	Achieve maximum annual weighted average power utilization effectiveness (PUE) of 1.4 by FY 2015.	Large Data Center currently at 1.52; completion of data center study to develop plan for obtaining PUE < 1.4 in FY 2012.	Develop funding strategy as required based upon report issued from data center study.	**Low**
7.3	Ensure 100% of eligible PCs, laptops, and monitors have power management actively implemented	LANDesk power management implemented on all suitable systems.	Continue to assess if any additional systems can use the power management systems.	**Low**

SC/SSPP /OMB Goal	DOE Goal	Performance Status	Planned Actions & Contribution	Risk of Non-attainment
	and in use by FY 2012.			
Goal 8: Agency Innovation & Government-Wide Support				
8.1	Agency Innovation & Government-Wide Support.	On-site generation.	Completion of the construction of the Solar Test Array.	**Low**

II. PERFORMANCE REVIEW AND PLAN NARRATIVE

GOAL 1: Greenhouse Gas Reduction and Comprehensive Greenhouse Gas Inventory

GOAL 1.1: ENERGY INTENSITY REDUCTION

Reduce energy intensity by 30% by FY 2015 from a FY 2003 baseline.

Figure 1. Chiller display.

Figure 2. Steam generation and monitoring.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL's current level of energy intensity is 297,605 Btu/GSF, based on CEDR FY 2012 data. This level represents a cumulative reduction of 8.1% from the FY 2003 baseline of 323,780 Btu/GSF. BNL is striving to meet the 30% reduction goal by 2015. The 2012 CEDR energy report and the final *Excluded Buildings and Trailers Self-Certification* are reported in Appendix A, *Energy Consuming Excluded Buildings and Trailers List*, and Appendix D, *CEDR FY 2012,* respectively.

We currently enter all of our High-Performance and Sustainable Buildings (HPSB) metered buildings into ENERGY STAR Portfolio Manager. These, along with other additions, account for a total of 57 buildings metered to date.

Within the last four years, surveys of 100% of BNL's buildings were completed that met the requirement to be surveyed. In addition, we established a plan to ensure the evaluations are on-going as required.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

BNL will implement energy efficiency projects between now and FY 2015 that should significantly reduce the intensity of energy usage when compared with the FY 2003 baseline. Projects are selected primarily by evaluating their life cycle costs (less than or equal to 25-year simple payback). In worksheet 3.5 of Appendix D, *CEDR FY 2012*, we list projects that, if implemented, are estimated to reduce energy intensity by approximately 30%.

It is important to note that the anticipated growth in both staff and facilities will offset total energy savings. We will continue to seek out and implement additional projects striving to meet the goal of reducing BNL's facilities energy use intensity by 30% by FY 2015.

BNL has identified the following projects that will reduce energy intensity further:

- Energy Conservation Measures – These measures will be established and financed via a Utility Energy Service Contract (UESC) as well as with operational funds. We targeted total reductions to meet or exceed the 30% reduction goal. The work with UESC began in September 2010, and Phase I implementation is projected to start in early to mid 2013. The measures will include the following:

    - Improve efficiency in supplying chilled water *(see Figure 1)*
    - Upgrade lighting throughout the Laboratory
    - Install building controls with enhanced temperature setback

    Further UESC Phases and other planned initiatives include:

    - Provide free cooling
    - Improve the steam system (*see Figure 2*)
    - Combine heat and power and/or biomass

- HVAC Setback – A setback capability for heating, ventilation, and air-conditioning systems (HVAC) will be installed. The Facility Complex Managers and their staff will evaluate systems continually to ensure this function is operating as intended. We will capture setback use by using the new Building Automation Program. Facility Complex Managers will communicate with building occupants about energy usage and the benefits of HVAC setback and energy conservation. We will modify lease agreements to incorporate setback clauses. In addition, we will enhance our existing preventative maintenance (PM) program for all HVAC systems.

- Steam Charge-back – We will implement a steam cost charge-back program to encourage energy conservation. BNL uses direct charges to building occupants for electricity and chilled water, and finds it to be one of the most effective methods to increase energy conservation. In FY 2010, a steam charge-back program was piloted; it will be phased in to full cost recovery program over several years to accommodate the varying financial impacts

to each building's occupants. It is estimated that this should provide an energy savings of approximately 62,000 mm Btu/year.

- Lighting Upgrades – We plan to continue BNL's ongoing program of upgrading current lighting with high efficiency replacements. Where applicable, automated controls will be installed. It is estimated that this will provide an annual savings of approximately 4,000 mm Btu/year.

- Energy Audits – Energy audits of HVAC systems, lighting, and office equipment will continue to be used to identify opportunities for energy conservation. The findings will help to develop policies on operation and equipment needs. These audits will be performed in conjunction with our ongoing condition assessment surveys in order to reduce additional costs and administrative oversight needs, with savings of approximately $45,000/year.

BNL is in the final stages of completing the necessary documentation to initiate a Utility Energy Service Contract (UESC). The first task order is anticipated to be awarded in early 2013 and will provide a nearly 8% reduction in energy intensity. We anticipate awarding additional Task Orders in the near future to obtain even greater reductions.

BNL had direct appropriations for energy conservation efforts of over $1.5 million in 2012 and expects to spend over $2 million/year in 2013 and beyond.

BARRIERS

Substantial investment is required in order to implement enough projects to meet the 30% energy intensity reduction goal. As indicated, BNL is in the process of implementing a Utility Energy Service Contract, with the first Task Order providing an estimated 8% reduction. Additional projects and funding will be required in order to meet the goal. It has long been demonstrated that finding cost-effective projects is difficult at BNL and this is critical for alternative financing mechanisms such as a UESC or an ESPC.

Cost-effectiveness of energy projects is the biggest barrier to meeting the 30% reduction goal.

GOAL 1.2: ELECTRIC FROM RENEWABLE SOURCES

Achieve 5% annual electricity consumption from renewable sources in FY 2010 – 2012, and 7.5 % by FY 2013 onward.

Figure 3. Worker at the Long Island Solar Farm.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL purchased 38 million kWh of RECs for 2012 in order to satisfy this requirement. This equals 10% of our total usage of electric and thermal energy.

BNL was an instrumental partner in the development of the Long Island Solar Farm (LISF), currently the largest solar photovoltaic (PV) facility in the Northeast. The LISF is located on 195 acres of land at BNL and became operational in November 2011. It provided 50 million kWh/yr of clean renewable energy to Long Island in FY 2012.

BNL is also in the process of developing an 800 kW on-site solar PV facility, which will be used for research purposes as well as provide BNL with an estimated +700,000 kWh/year of renewable energy *(Figure 3).* This facility, part of the Northeast Solar Energy Research Center (NSERC), is expected to become operational in late 2013.

We have implemented the following renewable energy projects on-site:

- A solar thermal hot water heating system in Building 461 (Gymnasium)
- Solar-powered traffic signals in various locations
- Solar-powered lights in remote parking lots
- A solar hot-water demonstration project integrating flat-panel solar hot water collectors and a high efficiency condensing oil-fired boiler in Building 30 (Brookhaven Center). This is a partnering project, with funding from the New York State Energy Research and Development Authority (NYSERDA), the Federal Energy Management Program (FEMP), and BNL.

Although BNL has championed renewable energy projects, they are rarely economically favorable.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

The following actions are under way or planned to start within the next five years:

As indicated, BNL is constructing a solar PV research array of approximately 0.8 MW in 2013 which will provide an estimated output of 700,000 kWh/yr and reduce GHG emissions by 500 $MtCO_2e$ per year. This research array is a result of the LISF project.

In FY 2013, BNL will complete a detailed Combined Heat and Power (CHP) and biomass study which will expand upon the recent preliminary feasibility studies. This detailed study will evaluate the viability of integrating a CHP and/or biomass system to gasify wood waste from local sources to fuel BNL's Central Steam Facility. If viable, there is the potential for the renewable fuels to support up to 80% of steam production.

Also in FY 2013, we will undertake a study evaluating the use of wind energy to generate electricity. This study will focus on the feasibility of establishing a small-scale demonstration project (0.5 to 2 MW) at BNL and the potential impacts to the BNL grid.

We will continue to use bio-based fuel for satellite boilers and diesel-fueled utility vehicles, and will expand the use of bio-based fuels for on-site vehicles.

We will continue to purchase renewable energy credits (RECs) as appropriate.

BARRIERS

The viability of virtually any renewable energy project rests on the applicability of federal tax credits and other incentives to make the project affordable to BNL. If BNL/DOE were to directly construct a wind or solar PV project, these credits and incentives would not apply.

In the case of the LISF, the willingness of the utility company (the Long Island Power Authority) to purchase the energy at rates higher than market prices through a 20-year power purchase agreement (PPA) made the project economically viable at BNL. With the difficulty of finding suitable land areas and site conditions on Long Island, it is highly unlikely that the LISF would have been feasible without BNL's and the DOE's strong efforts to assure the provision of this location. The effect of the estimated 40^{+}million kWh/yr of power generated from the LISF project does not give BNL credit toward our renewable energy goal but it does give BNL credit toward its GHG emissions and it benefits the entire region as well.

GOAL 1.3: SF_6 REDUCTION

Figure 4. The Interdisciplinary Science Building I (December 10, 2012).

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Mandatory greenhouse gas reporting requirements of 40 CFR 98 Subpart DD for electrical transmission and distribution equipment are not applicable to BNL since the cumulative nameplate capacity of SF_6 in BNL's inventory of high energy equipment is less than 17,820 pounds. BNL will, however, adopt Subpart DD monitoring procedures to accurately and consistently account for SF_6 emissions occurring during equipment installation, servicing, and decommissioning.

Recognizing that BNL's existing high energy equipment leak detection and repair program could be improved, BNL initiated the preparation of a draft plan to manage high energy equipment that utilizes SF_6 as a dielectric medium. The intent of the plan, modeled after BNL's Refrigerant Management Plan, is to establish a proactive process to identify and repair SF_6 leaks and to safely recover, recycle, and reclaim sulfur hexafluoride during equipment operations and maintenance. The plan will incorporate utility industry recognized practices to safely handle SF_6 and minimize releases.

In 2012, we also developed specifications for the contractor responsible for the ASHRAE Standard 110 performance acceptance tests of new high-efficiency low-flow laboratory hoods in the Interdisciplinary Science Building and the three new Light Source II Laboratory Office Buildings. The new specifications use nitrous oxide (N_20) as an alternative tracer gas to SF_6. Since an equivalent amount of N_20 (2 pounds) will be used in place of SF_6 for each performance test, 21.4 metric tons of carbon dioxide equivalents (mT CO_2e) will be avoided per test. With 60 laboratory hoods to be tested in the new Interdisciplinary Science Building *(Figure 4)* and another four hoods that will be tested in Laboratory Office Buildings, 1,397 mT CO_2e will be avoided in FY 2013.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

The high energy equipment management plan will be completed during the third quarter of FY 2013. Managers and technicians of the Energy & Utilities Electric Distribution Group are actively engaged in the development of the plan and will support its execution when it is finalized.

Upon completion, the plan will be reviewed with all Energy & Utility Division electric distribution technicians and supervisors. In addition, the Energy & Utility Division intends to bring in a contractor in February or March 2013 to provide comprehensive substation training classes for division electrical engineers, electrical distribution technicians and supervisors. The training will include a combined lecture and hands-on session covering SF_6 breaker inspections and maintenance.

BARRIERS

There are no foreseen barriers to accomplishing these planned actions.

GOAL 1.4: METERING

Achieve individual building or process metering for 90% of electricity consumed (by Oct. 1, 2012) and for 90% of steam, natural gas, and chilled water consumed (by Oct. 1, 2015).

Figure 5. Monitoring chilled water.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL has a long, successful history in advanced metering and currently meets this goal for electricity, natural gas, and chilled water *(Figure 5).* Advanced electric meters are installed in 283 buildings, advanced chilled water meters are installed in 32 buildings or loads with chilled water and all of BNL's natural gas supplied facilities have advanced meters installed as well.

Advanced steam metering is installed in four buildings. However, 62 buildings still have conventional steam meters that will be upgraded to advanced meters as appropriate. BNL will install new steam metering in large use buildings where steam metering is insufficient due to failing or inadequate metering with a goal of upgrading three or more meters per year. This will assist in our steam charge back effort described in Goal 1.1 *Energy Intensity Reduction*.

Due to the low cost of water, the installation of water meters is not economically justifiable. However, BNL's major facilities with cooling towers, as well as new buildings and major renovations will include water metering.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

We plan to continue to install metering in accordance with our metering plan, included as Appendix E.

BARRIERS

As indicated above, due to the low cost of water, the installation of water meters almost never economically justifiable on existing facilities. However, new facilities as well as major modifications to building water systems will include metering as appropriate.

GOAL 1.5: COOL ROOFS

Install cool roofs when economical for roof replacements. Unless project has a previous CD-2 approval, new roofs must have thermal resistance of at least R-30

Figure 6. Installing the cool roof on the Interdisciplinary Science Building I.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL is committed to enhancing the overall building thermal performance for new roofs. Consistent with Secretary Chu's memorandum of June 1, 2010, our procedures specify cool roofs with insulation values of up to R-30 for all new roofs, unless justified otherwise by life-cycle cost analyses. The specifications for the planned roof for the new Interdisciplinary Science Building I (ISB-I) were updated to achieve an R-30 rating even though this project was funded before the effective date of this directive *(Figure 6).*

All roofing projects were reviewed against the DOE cool roof criteria. While all roofs met the ASHRAE reflectivity requirements only one roof, ISB-I was also economically feasible to achieve an R-30 value.

The partial (3,100 ft^2) re-roofing of Building 725 met all the DOE criteria for a cool roof and FIMS was updated to reflect this effort.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

All roofing projects will be reviewed against the Cool Roof standards. If life-cycle analysis demonstrates that it is economically feasible, the roof will be designed to meet both the ASHRAE Cool Roof criteria as well as insulation value of R-30. The annual reminder of this requirement has been sent to all potential roofing project managers.

ISB I and Bldg. 734, which will be completed in FY 2013, will meet the DOE Cool Roof criteria with ISB I also achieving an R-30 value. The data will be added to FIMS. In addition, The NSLS-II project is constructing a 9,000 sf long-beam line addition to the Ring Building, Bldg. 740. Its roof will meet the DOE Cool Roof criteria.

BARRIERS

There are no barriers to meeting the DOE Cool Roof requirements for new construction. For re-roofing projects, while there are no barriers to meeting the ASHRAE reflectivity standards for cool roofs, there are significant economic barriers to achieve R-30 insulation values. The economics is driven by several factors including the current "R" value, quantity of equipment and penetrations on the roof, and other construction aspects such as curbing. In all cases, BNL maximizes the "R" value based on the roof condition up to and including R-30.

GOAL 1.6: TRAINING

With the implementation of the Integrated Facility Management model several years ago, BNL committed to training all facilities management personnel to recognized industry standards. Since inception, all three Facility Complex Managers within the core complexes have obtained the International Facility Management Association (IFMA) designation of Certified Facility Manager (CFM). In addition, most Facility Project Managers have obtained IFMA's Facility Management Professional (FMP) credential. Some staff are also pursuing the Facilities Management Administrator (FMA) designation from BOMI International (Independent Institute for Property and Facility Management Education). BNL is awaiting guidelines from DOE on other training requirements and will strive to meet those requirements as well. In FY 2012, BNL spent $27,800 on EP Act 1992 Training.

GOAL 1.7: NET ZERO ENERGY

Achieve net zero energy in new or major renovation facilities.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

A review of the FY 2013 planned projects did not reveal any net zero energy candidates.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

There are currently no plans to build the type of facility (typically office or residential buildings) that are conducive to achieving a net-zero designation. However, with the installation of the BNL R&D solar PV array at the Northeast Solar Energy Research Center (NSERC), we are evaluating potential options that may allow BNL to have a net-zero building on site. Another option is to evaluate potential for achieving a net-zero rating at BNL's planned "Discovery Park". "Discovery Park" may include at least one alternatively financed building. Plans also include replacing the remaining wood structures at the Lab and building the SGRID3 smart grid research center at this site.

BARRIERS

It is difficult to currently anticipate risk of achieving this goal as BNL does not have any applicable projects scheduled at this time.

GOAL 1.8: FACILITY ENERGY USE EVALUATION

Evaluate 25% of 75% of facility energy use over 4-year cycle.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Facility Condition Assessments and Energy Audits are now performed at the same time. This reduces costs and ensures that a 4-year cycle is maintained. Savings are estimated at approximately $45,000/year. Energy audits of HVAC systems, lighting, and office equipment will continue to be used to identify opportunities for energy conservation. The audit findings will also assist in developing policies on equipment operation as well as equipment needs.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

BNL will continue to complete Facility Energy Use Evaluations on at least 25% of the applicable facilities each year.

BARRIERS

The only barrier to continued Facility Energy Use Evaluations is the availability of sufficient funds and other priorities. At the present time, no immediate concerns are known.

GOAL 1.9: GREENHOUSE GAS REDUCTION, SCOPE 3

Reduce Scope 3 GHG by 13% by FY 2020 from a FY 2008 baseline.

Figure 7. Carpooling at BNL.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Table 2 illustrates that, overall, BNL reduced Scope 3 GHG emissions from all combined source categories. Scope 3 GHG emissions are down 20.5 % from FY 2011 (18,358 MtCO_2e), and 9.2 % lower than the FY 2008 baseline value.

Table 2. Scope 3 Greenhouse Gas Emissions.

	FY 2008	FY 2011	FY 2012
Category	**Mt CO_2e**	**Mt CO_2e**	**Mt CO_2e**
Transportation & Distribution Losses	11,124	12,136	7,723
Commuting	4,795	5,666	5,987
Airline Travel	3,399	4,715	4,116
Rental Cars	347	209	217
Personal Auto (Business)	126	149	132
Waste	212	202	183
Totals	**20,003**	**23,077**	**18,358**

Transportation and Distribution Losses

From FY 2008 to FY 2012, GHGs from electrical transmission and distribution losses dropped 30.5% or 3,401 MtCO_2e despite a 19.9% increase in purchased electricity. In 2012, hydro power purchases of 118,231 MWh from the New York Power Authority (NYPA) accounted for 42.5% of all electrical power purchases. As a result, transmission and distribution loss GHGs dropped by

2,865 $MtCO_2e$ as lower Upstate New York subregion eGrid emissions factors were used to calculate hydro power transmission and distribution GHGs. Lower eGrid GHG emission factors for the Long Island subregion in FY 2012 versus those in FY 2008 combined with a decrease in the transmission and distribution loss factor from 6.85% in FY 2008 to 6.18% in FY 2012 also helped to reduce transmission and distribution loss GHGs .

Commuting

Commuting GHGs rose 5.7 % or 221 $MtCO_2e$ from FY 2011. While the average employee population commuting each day and the number of individuals ridesharing each day *(Figure 7)* stayed fairly constant, the average employee round trip commute distance rose from 27.14 miles in FY 2011 to 28.86 miles in FY 2012. This rise in the average commuting distance accounts for the corresponding increases in the commuting distance traveled by single occupancy passenger cars and single occupancy light duty trucks noted in Section 8.3 of BNL's CEDR.

In 2012, BNL staff met with administrators of MetroPool Long Island, the New York State Department of Transportation regional commuting services contractor for Long Island, to discuss options to enhance the current BNL ridematching services for BNL employees interested in ridesharing. MetroPool has proposed creating a rideshare portal customized to meet the needs of BNL employees, that will include ridematch maps that can either display the location of homes of employees living within a defined radius of the person seeking rideshare partners, or will identify the location of homes of other employee near the route of the employee seeking partners. The proposed portal would include other features, such as the locations and direction to defined park & ride lots, a commute cost calculator, a link to information about the Guaranteed Ride Service offered to all ridesharing employees, and a live link to the MetroPool Traffic and Transit Conditions Map.

Also in FY 2012, the Policy Council approved Human Resources Division plans to expand flexible work week and compressed work week schedules to include non-bargaining nonexempt employees and for non-bargaining employees respectively. Employees approved to work a 9-80 compressed work week schedule would reduce their commuting GHG footprint by 10%, as they would reduce the frequency of their daily work commute by one day every two weeks.

Airline Travel

Airline travel GHGs dropped by 599 $MtCO_2e$ down 12.7% from the FY 2011 total. However, FY 2012 airline travel GHGs are 21.1% above the FY 2008 baseline.

Four proposals to reduce airline travel GHGs were presented to the Policy Council suggesting fixed percentage for annual airline travel mileage reduction targets that each directorate would attempt to meet. Since more that 91% of airline travel GHGs result from trips taken by staff in research organizations, the Policy Council did not approve any of the proposals because the travel reductions would significantly impact travel considered essential to meeting mission critical research objectives. Following the presentation, the Policy Council recommended the formation of a workgroup to thoroughly examine and identify paths to reduce GHGs in each of the four employee business travel categories.

Rental Cars

GHG emissions resulting from rental vehicles used for employee business travel rose 3.7%, but are still 38% below the 2008 baseline value.

Personal Auto (Business)

GHGs from employees using their personal vehicles for business use have increased just 4.8% since FY 2008, which is far below comparable emissions when considering the growth in the number of full-time employees since 2008.

Waste

Since 2008, GHGs from contracted waste are down 13.5% due to a corresponding reduction in volume of waste transferred to the Hempstead Resource Recovery Facility. Additionally, diverting cafeteria food preparation wastes from the waste stream helped reduce waste levels. These food preparation wastes are used at the sewage treatment plant to raise plant biochemical oxygen levels which, in turn, aid in the de-nitrification process and supplement the biomass at the sewage treatment plant.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

To achieve the 13% Scope 3 GHG emission reduction goal and the 12% employee business travel GHG emission reduction goal, BNL must lower overall Scope 3 GHGs and employee travel GHGs by 2,600 $MtCO_2e$ and 1,040 $MtCO_2e$, respectively.

In FY 2013, on the recommendation of the Policy Council, a working group will be formed to examine and expand possible options for reducing GHGs from each of the four employee business travel categories discussed above. Options to be considered will include:

- The adoption of a site-wide 9/80 work schedule;
- Establishing employee incentives to encourage electric, plug-in hybrid, hybrid and high mileage vehicle purchases;
- Establishing restrictions on employee use of full size and luxury vehicles as rentals and encourage the rental of hybrids;
- Identifying job classifications across the site where Telework arrangements between employees and supervisors are practical;
- Identifying non-mission critical workshops and conferences that require airline travel where attendance is optional or where the number of attendees from BNL may be reduced.

Additional objectives for FY 2013:

- Track participation in the Wading River Carpool Coop created by employees in November 2012 in the aftermath of gasoline shortages following Superstorm Sandy;
- Consider expanding the Carpool Coop concept to areas where a large number of employees reside;
- Continue to enhance employee awareness of existing teleconferencing resources and encourage their use;
- Enhance employee awareness of the employee travel GHG reduction goal;
- Educate employees about the value of recycling and the importance of separating recyclables from municipal wastes;
- Work with MetroPool to complete and roll out the new BNL Rideshare Portal;
- Human Resources will amend the SBMS Flexible Work Arrangements subject area to include new procedures to enable non-bargaining nonexempt and for non-bargaining employees to choose to work flexible work week or compressed workweek schedules that will include supervisor guidelines for their approval.

BARRIERS

In FY 2013 to FY 2016, the anticipated rise in purchased electricity, as commissioning of NSLS-II and the Interdisciplinary Science Building occur, will proportionately increase the transmission and distribution losses and the associated GHGs. In addition, the expected growth in the employee population as these facilities are commissioned is likely to contribute to increases in commuting GHGs and airline travel GHGs. If the construction and operation of a 4 MW combined heat and power plant is approved, it would help to mitigate some of the expected increases in electrical power transmission and distribution loss GHGs.

GOAL 1.10: GREENHOUSE GAS REDUCTION, SCOPE 1 & 2

Reduce Scopes 1 & 2 GHG by 28% by FY 2020 from a FY 2008 baseline.

Figure 8. Bicycle tour of the Long Island Solar Farm.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Brookhaven National Laboratory (BNL) is committed and on target to reduce GHG gas Scope 1 and 2 emissions by 28% by FY 2020 when compared to the FY 2008 baseline. However, BNL faces challenges in doing so, particularly because our estimated programmatic growth is expected to increase GHG emissions by 95% by 2020 when compared to the FY 2008 baseline *(Figure 9 and Table 3).*

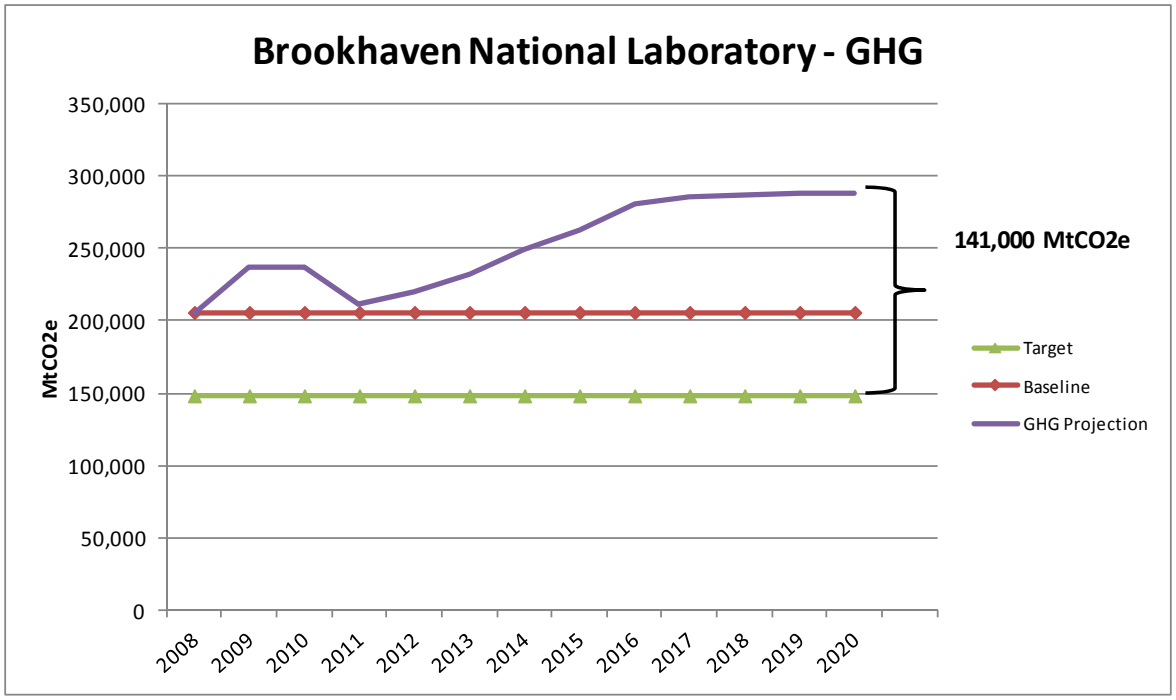


Figure 9. Scope 1 and 2 GHG emission projection.

Table 3 lists BNL's baseline, reduction target and projected FY 2020 GHG emissions.

Table 3. Scope 1 and Scope 2 GHG overview.

Emissions	$MtCO_2e$	Change Compared to	
		2008	Target
2008 GHG Emissions	205,542		
28% GHG Reduction Target	148,000	– 28%	
2020 Projected GHG Emissions	289,000		+95%
Reduction or Offset Requirements	**141,000**		

In order to achieve the 28% reduction goal, BNL must aggressively support innovative projects, energy conservation and renewable energy projects, operational improvements, infrastructure modernization, renewable energy credits (RECs), and carbon offsets. This will involve seeking and obtaining funding from every possible source, along with cultural changes and increased emphasis on management practices.

BNL's overall GHG emissions were lower in FY 2012 when compared to FY 2011. This was due to BNL's recent allocation of 15 MW of hydropower from the New York Power Authority. However, there continues to be some confusion regarding the calculations contained within the CEDR regarding GHG emissions for BNL. The CEDR indicates Scope 1 and Scope 2 GHG emissions of 138,020 $MtCO_2$. However, BNL's calculation indicates it should be approximately 92,100 $MtCO_2$. We will continue to work to resolve this discrepancy. Regardless, BNL is currently below the FY 2020 target of 148,000 $MtCO_2$.

We evaluated various options and formulated a robust path forward. A Site Sustainability Steering Committee was formed in 2010 in order to better integrate actions across the Laboratory and achieve a comprehensive approach to attaining our GHG targets. The committee is comprised of senior leadership from Science and Operations, which enables the necessary visibility and management attention for this important issue. This Steering Committee has been instrumental in advising and coordinating the progress to date as well as the path forward. Some of these efforts include the following:

Starting in March 1, 2011, BNL began receiving 15 MW of hydropower from the New York Power Authority. The estimated annual consumption of 115,600 MW of hydropower reduces BNL's GHG emissions by approximately 78,000 $MtCO_2e$ per year. This is now included in the CEDR calculation.

Starting in November 2011, the Long Island Solar Farm (LISF) began producing approximately 32 MW of alternating current electricity. This project will avoid GHG emissions of 28,000 $MtCO_2e$ or more per year.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

To continue progress and ultimately achieve our sustainability goals, BNL must proceed aggressively with energy conservation and renewable energy projects, operational improvements, infrastructure modernization, RECs/carbon credits, innovation, and other actions needed to meet the GHG requirements. This will involve seeking and obtaining funding from every possible source, along with internal cultural changes and increased emphasis on resource management. We realize that a multi-pronged approach is necessary to achieving long term goals. Table 4 lists the current and proposed components of this approach and how each will contribute to attaining the GHG emissions goal.

Table 4. Actions in Process for Offset or Reduction of Scope 1 and 2 GHG Emissions.

Planned Actions	MW	MWh/yr	$MtCO_2e$	%	Estimated Cost ($)	Comments
Energy Intensity Reduction – UESC Phase I			– 7,000	–5	13,000,000	UESC Phase I – Estimated contract award in 2013.
Energy Intensity Reduction – UESC Phase II			-14,000	-10%	9,440,000	Based on meeting DOE 30% Goal and average 10 SPP (The maximum period that can be financed). Start 2014, over 2 years. This is optimistic and not likely due to difficulty in developing enough cost-effective projects.
Hydro Allocation	15	120,231	-78,000	-55	N/A	15 MW of NYPA hydro power
BNL Solar PV (R&D)	0.7	430	- 500	0		R&D array at 700kW + in early FY 2014
REC's		38,000	-24,600	-17	14,839	REC's purchased to meet 7.5% R.E. goal
Long Island Solar Farm Credit	31.5	38,000	– 24,600	–17		Started 11/1/11. Credit for hosting LISF based on purchasing ~ same amount of REC's as the LISF produced. LISF output exceeded estimates.
Total actions in progress			**– 148,700**			
Shortfall			**-7,700**			

As shown in Table 4, these actions are more than sufficient to meet the GHG goal by a modest margin. However, it assumes BNL is able to meet *Goal 1.1 - Reduce Energy Intensity by 30% by FY 2015 from a FY 2003 baseline,* which plays a significant role in reducing GHG emissions. These efforts are identified in Table 4 as *Energy Intensity Reduction*. Support for this reduction is dependent on using a third-party financing arrangement in the form of a Utility Energy Services Contract (UESC). More detail on this initiative can be found under *Goal 1.1 – Reduce Energy Intensity by 30% by FY 2015 from a FY 2003 baseline* as well as in the *Barriers* section under this goal.

BNL is in the process of developing an on-site solar photovoltaic (PV) research facility that will provide power to the BNL grid. The facility will be sized between 0.7 and 1.0 MW. The design is nearly complete and bidding is expected by Spring 2013. The facility is expected to be completed mid to late 2013. The estimated annual output of 730 MW hr/yr will result in reducing BNL's GHG emissions by approximately 500 $MtCO_2e$ per year starting in late 2013.

In the event the energy intensity reduction efforts fall slightly short, BNL undertook an initial, high-level assessment to evaluate options and delineate a path forward *(Table 5).*

Table 5. Options to Meet Scope 1 and 2 Offset of 14,000 $MtCO_2e$ if the Energy Intensity Goal Is Not Met.

Options	MW	MWh/yr	$MtCO_2e$	%	Estimated Cost ($)	Comments
Option 1: Combined heat and power (CHP)	4	32,000	– 14,000	100	8,400,000	Cogeneration at 52% efficiency vs. 30% for LI. + thermal; optimistic assumptions; complete 2017
Option 2: REC's/carbon credits in kWh		22,000	– 14,000	100	$286,000/yr	Based on $13/MWh or $20/Mton

In this analysis, BNL assumes the price of carbon to be at $20/ $MtCO_2e$. This is considerably higher than current pricing from regional auctions, but we believe it to be appropriate as we expect carbon prices to increase. Furthermore, this represents the DOE estimated "social cost of carbon".

Cost estimates for the wind farm and solar PV options were not included in this year's SSP due to their high cost as compared to other options.

Although the simplest path to achieving the required reductions is through the purchase of RECs (Option 2), we are interested in further investigating the practicality and cost effectiveness of an alternatively financed combined heat and power plant (CHP) (Option 1). Previously conducted evaluations indicated that for BNL's thermal load, the maximum practical size for a CHP was approximately 20 MW. However, based upon the load of current projects and projects under development, a 4-5 MW plant would be sufficient. A 4 MW CHP would provide up to 14,000 $MtCO_2e$/yr in GHG reductions. This reduction, when combined with our other initiatives, will exceed our GHG reduction target. Furthermore, a 4-5 MW plant is easier to manage than a larger facility, and it fits with potential biomass options.

BNL completed a preliminary CHP study during FY 2012 and determined further evaluation is warranted. This will include permitting and potential conflicts with existing power-purchase contracts. We will also explore various fuel options, such as biomass, biofuels, and natural gas.

BNL plans to prepare a sensitivity analysis for all identified options, factoring in various assumptions on discount rates, the price of carbon, the price of RECs, as well as fuel price and availability. We expect to complete this study by the end of FY 2013. The projected impact of our current strategy with Option 1 implementation is illustrated in Figure 10.

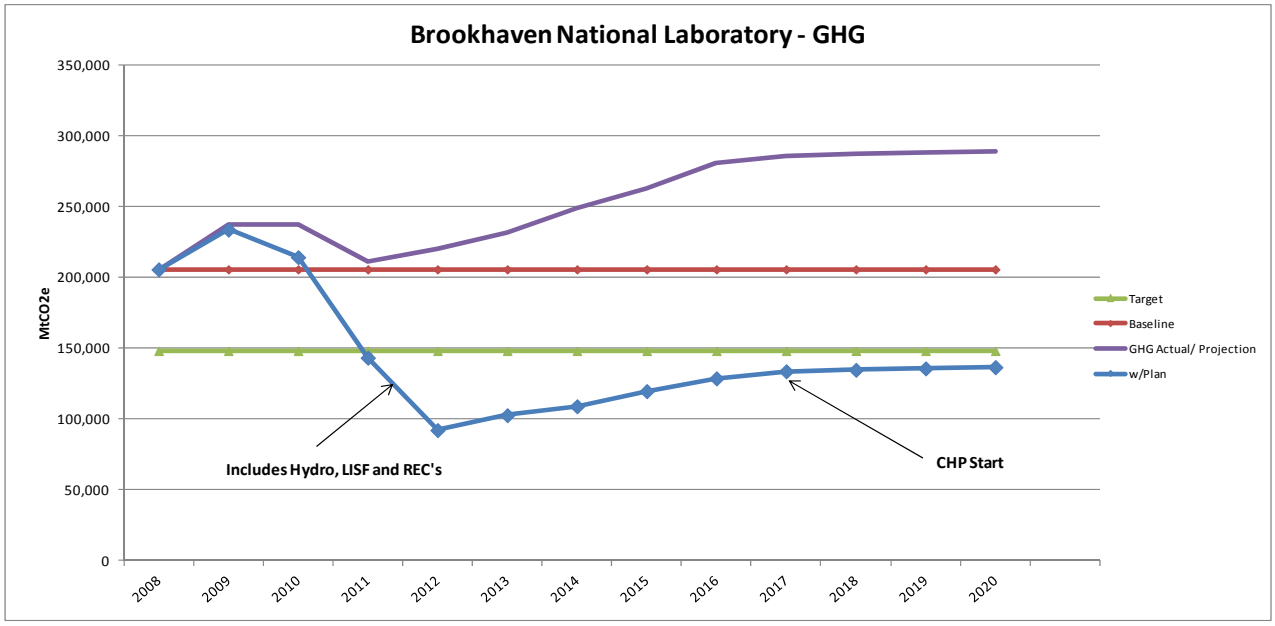


Figure 10. Effect and timing of current GHG reduction strategy.

BARRIERS

Achieving the GHG reduction goal is contingent upon BNL's success in realizing the Energy Intensity reduction goal of 30%. We have comprehensively evaluated the BNL site for opportunities including Facility Energy Use Assessments, internal auditing, as well as Energy Saving Performance Contracts (ESPC) and UESC initiatives. We are currently developing the first phase of a UESC. However, this falls short of the total reduction requirements. While we are confident we can find additional projects, there are currently doubts as to the ability to identify enough cost-effective projects that could be financed through an ESPC or a UESC.

GOAL 2: Buildings, ESPC Initiative Schedule, and Regional & Local Planning

GOAL 2.1.A: EXISTING BUILDINGS

Ensure 15% of existing buildings sized greater than 5,000 gross square feet (GSF) are compliant with the five guiding principles (GPs) of HPSB by FY 2015.

Figure 11. Building 935 - BNL's Science Learning Center and Staff.

Figure 12. Building 935 indoor air quality improvements.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Significant progress was made in FY 2012 and is expected to continue through FY 2013. Design was completed on all Energy Conservation Measure projects and funding allowed for early construction starts for the Building 935 Indoor Air Quality Improvements *(Figures 11 and 12),* installation of occupancy sensors in several buildings, and pre-purchase of the roof top HVAC unit (RTU) for Building 438 and the 6 RTU's for Building 817.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

Projects expected to be completed in FY 2013 include the replacement of the RTU for Building 438 (currently in progress), completion of the occupancy sensors in all HPSB Buildings, installation of night setback controls in Buildings 438 and 935, and completion of the HPSB improvements in Building 817. Changes to HPSB related policies and procedures commenced in FY 2012 and will continue through FY 2013.

BARRIERS

This task is rated with a medium risk due to challenging funding profiles and the number of projects that are scheduled to be completed in FY 2014 and early FY 2015.

GOAL 2.1.B: NEW CONSTRUCTION, RENOVATIONS, AND ALTERATIONS OF BUILDINGS

Ensure that all new construction, major renovations, and alterations of buildings greater than 5,000 GSF comply with the GPs.

Figure 13. The Interdisciplinary Science Building I.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

All new construction, major renovations, and alterations of buildings greater than 5,000 GSF must comply with the Guiding Principles (GPs). DOE considers buildings meeting the following criteria as complying with the GPs:

- Any building that achieves LEED-EB Silver or higher or LEED-NC Gold or higher;
- Any building that achieves a Green Globes-NC rating of four or a Green Globes Continual Improvement of Existing Buildings (CIEB) rating of three;
- Any building that has been occupied for more than one year that achieves Living Status designation by the Living Building Challenge (although included as policy in the 2012 SSPP, these equivalencies are contingent upon OMB and CEQ approval).

To define “major renovations” BNL, will use the High Performance Sustainable Buildings (HPSB) Working Group FAQ listed in the *DOE Assessment Guidance Tool*, June 27, 2008, as well as the supplement to the *Secretarial Memorandum on DOE Federal Leadership in High Performance and Sustainable Buildings*, February 27, 2008.

The Interdisciplinary Science Building I was in construction in FY 2012 and is designed to achieve LEED Gold certification *(Figure 13).*The NSLS-II Ring Building was completed in FY 2012 and is designed to be LEED Certified. The five NSLS-II Laboratory/Office Buildings (LOBs), which were in various stages of construction in FY 2012, are designed to meet LEED Silver requirements at a minimum *(Figure 14).* These applications for the NSLS II buildings have been submitted.

Figure 14. One of the Laboratory/Office Buildings of NSLS-II.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

In FY 2013, construction of ISB I as well as all NSLS-II LOB's are scheduled to be completed. BNL expects to submit the final report for LEED certification on ISB I early in 2013.

The next major new building project will be the construction of ISB II. It will be designed to meet the Guiding Principles with a goal of obtaining LEED Gold. BNL will be seeking CD-1 in FY 2013 and expects to start project design in FY 2015.

BARRIERS

BNL does not anticipate any barriers.

GOAL 2.2: ESPC INITIATIVE, IE, AND THIRD PARTY FINANCING

As indicated previously, BNL is in the final stages of completing the necessary documentation to initiate a Utility Energy Service Contract (UESC). The first task order is anticipated to be awarded in early 2013 and will provide nearly an 8% reduction in energy intensity and 7,000 $MtCO_2e$ of GHG reduction.

BNL has expended considerable effort developing this UESC and is confident it will be successful. It includes a robust Performance Assurance Plan. Further, independent cost estimates were completed, and a “lessons learned” forum is planned with other Laboratories that have recent ESPC/UESC contracts.

We anticipate awarding additional Task Orders in the near future to obtain even greater reductions.

GOAL 2.3: REGIONAL AND LOCAL PLANNING

Regional Transportation Planning:

Through BNL’s Master Planning process the Laboratory continues to collaborate with the State and Local Transportation Departments. For example, in FY 2011 New York State Department of Transportation gave BNL the opportunity to comment on the “Sunrise Highway Corridor Sustainable Transportation Study”, and we expect similar cooperation in the future.

In addition, BNL is working with the Long Island Sustainability Council to support their transportation agenda, which includes, in part, determining the viability of the Laboratory as a transit-served center, and expanding pedestrian and bicycle mobility. The Long Island Sustainability Council will formalize the integration of local and regional planning with each site’s 10-year planning process. However, BNL is located on eastern Long Island, a more rural setting, and is not well served by the existing public transportation infrastructure. Discussions have been held with Suffolk County Bus to ascertain the viability of establishing a bus route to serve BNL commuters. Such a service would have to be self-supporting and based upon survey results, ridership could not be guaranteed.

BNL continues to review transportation options and incorporate considerations for sustainable building locations and sites into acquisition plans for offsite office buildings, offsite user housing, and other facilities. The process has not been formalized into policy and guidance documents. BNL only has one lease which is within close of proximity of BNL. As no public transportation stops at BNL it was a non-factor in the decision process to for selecting the lease site.

With regard to on-site employee movement, the overall landscape of the BNL site is changing. Research centers are being located centrally which will foster better pedestrian and bicycle movement between facilities. An on-site shuttle service is also available to move staff from

building to building thereby reducing single occupancy ridership. A shuttle service is also provided from the Long Island Railroad station at Ronkonkoma and from Stony Brook University.

National Environmental Protection Act

As required under NEPA legislation, energy usage is considered as part of all Environmental Impact Statements and Environmental Assessments. NEPA documents also include impacts of construction vehicles on local traffic.

Renewable Infrastructure

The BNL site was chosen as a host site for the construction of a 32 MW solar power station. The Department of Energy worked closely with the Long Island Power Authority and BP solar in the development and construction of the facility. Construction was completed in late October 2011 and power delivered to the grid on November 1, 2011. Solar power generated from the 200 acre photovoltaic array will produce enough electricity to power 4,500 homes *(Figure 15).*

Figure 15. Long Island Solar Farm at BNL.

BNL expects to complete construction of the Northeast Solar Energy Research Center in 2013. This research center will provide for developing, testing and affirming performance of the next generation solar energy power systems. BNL is also working collaboratively with Stony Brook University on the development of better and more efficient battery systems to improve long-term energy storage needed to make solar power a more viable energy alternative.

BNL's compressed natural gas service continues to be used to fuel the BNL CNG fleet and memoranda of agreement are in place to permit use by the Town of Brookhaven and Dowling College. Losses to the BNL fleet have, however, reduced use of natural gas as an alternative fuel. E-85 and biodiesel continue to be utilized as replacements for the pure petroleum counterparts.

Figure 16. Wildlife at BNL.

Environmental/Ecosystem Management

BNL maintains proactive environmental and ecological management programs intended to protectand improve natural resources. As part of BNL's natural resource strategies, BNL focuses on continuing its leadership role within the greater Long Island Central Pine Barrens ecosystem by participating on many local and regional committees and societies, such as the Central Pine Barrens Commission, Pine Barrens Society, Peconic Estuary Program, Long Island Invasive Species Management Area, and the Long Island Native Plant Initiative to ensure BNL is represented in the decisions that could impact wildlife management at BNL.

The Laboratory implemented precautions to protect on-site habitats and natural resources (Figure 16). Activities to eliminate or minimize negative effects on sensitive or critical species are either incorporated into BNL procedures or into specific program or project plans. Human access to critical habitats is limited. In some cases, habitats are enhanced to improve survival or increase populations. Even routine activities, such as road maintenance, are not undertaken until they have been evaluated and determined to be unlikely to affect habitat. BNL is committed to continually improve the natural environment of its site. Specific goals are established and tracked in the BNL Natural Resource Management Plan.

In 2012, BNL achieved the planned scope under the DOE's environmental management program with the completion of the decontamination and decommissioning of the Brookhaven Graphite Research Reactor. Through BNL's restoration program over the past 20 years, significant improvements in the BNL natural environment have been realized, such as the removal of contaminants from soils, groundwater, and the Peconic River both on and off the BNL campus. The effectiveness of these remediation projects are measured annually and reported to regulatory agencies, DOE, and the public. Efforts to complete the clean-up of groundwater will continue through 2030 for most volatile organic compound contaminants and 2070 for strontium 90.

BNL maintains strong positive relationships with regulatory agencies, environmental groups, local residents and other stakeholders. The principle modes of communication include routine interface with regulatory agencies and DOE through submittal of performance reports, conference calls and periodic meetings. The Laboratory communicates with local community groups and environmental groups through monthly meetings of the Community Advisory Council and through presentations at local community group meetings.

BNL also partners with many organizations to expand sustainability objectives outside BNL's campus. Activities in 2012 included the Log Island Earth Summit held during Earth Week, cosponsored by BNL and The Citizens Campaign for the Environment. BNL participated with several presentations relating to sustainability including renewable energy, the health of our waterways and regional approaches to preserving open space. Other events included hosting the Suffolk County Planning Commission as well as the Nassau and Suffolk Counties Soil Conservation District workshops on site. In November 2012, BNL hosted the first annual Long Island Natural History Conference, which was attended by more than 150 participants.

GOALS FOR 2013

Renewable Energy: BNL is committed to continue to support federal and local efforts at reducing reliance on petroleum based energy. Renewable energy research projects are being developed for the Northeast Solar Energy Research Center. Through implementation of the Natural Resource Management Plan, BNL will also measure and report on the ecological impacts of large scale solar installations.

Transportation: BNL continues to pursue increasing car pool ridership and is working with local authorities to examine mass transit opportunities. In FY 2013, BNL will continue to measure automobile occupancy rates and establish a working group to identify additional ways to reduce single occupancy vehicles. This working group will also examine alternate working schedules and other efforts to reduce scope 3 GHG emissions.

Environmental Resource Management: BNL continues to support natural resource improvements through implementation of the Natural Resource Management Plan. In FY 2013, BNL will evaluate management techniques to improve the health of the on-site deer herd, will field deploy a new tick management technique (Four Poster) and will host the next Long Island Natural Resource Conference and Long Island earth Summit on site.

The most significant barrier to BNL's performance in Regional Planning is its location. Due to the rural nature of BNL's surrounding area, service by mass transit is limited and locating BNL facilities near transit centers is impractical.

GOAL 3: Fleet Management

GOAL 3.1: FLEET ALTERNATIVE FUEL CONSUMPTION

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

Figure 17. Alternative fuel vehicles.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

Alternative fueling infrastructure exists for compressed natural gas, diesel, E85, and biodiesel *(Figure 17).* E85 is the alternative fuel of choice because the vehicles are readily available through the U.S. General Service Administration (GSA).

Some compressed natural gas vehicles have been removed from the fleet due to age or condition. The additional cost to a obtain replacement compressed natural gas (CNG) vehicles compared to the same vehicle capable of using E85 is $12,500. BSA will explore potential opportunities to obtain outside funding through local, state and federal programs/grants/subsidies to address additional costs associated with CNG new vehicle conversions or direct purchases.

Any CNG vehicles on the GSA schedule will be evaluated against the replacement need and the appropriate business case.

Biodiesel infrastructure is relatively limited due to storage capacity of the tank (1000 gallons), but all vehicles capable of using biodiesel are employed.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

BNL will continue to purchase as many alternative fuel vehicles as the replacement vehicle budget permits to substitute vehicles using petroleum fuel.

BARRIERS

The only potential barrier is funding.

GOAL 3.2: FLEET PETROLEUM CONSUMPTION REDUCTION

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

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL is reducing petroleum consumption by replacing gasoline and diesel vehicles with alternative fuel vehicles as budgets permit. BNL reduced its fleet by 30 vehicles on January 1, 2012 as part of its *Right Sizing the Fleet* Management Plan. The 30 vehicles were primarily petroleum vehicles.

BNL right-sizes the vehicles to accomplish the vehicles mission and reduce fuel consumption.

BNL uses idle reduction technology in some vehicles.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

Further fleet right-sizing efforts planned for FY 2013 will result in an additional reduction of 9 petroleum vehicles. Additionally, the fleet is budgeted to replace 10-14 vehicles with alternative fuel vehicles.

BARRIERS

BNL will review planned replacements with the GSA schedule to determine on a business case which alternative fuel vehicles will be selected in the replacement purchase.

The expansion of GPS technology beyond the pilot program will be determined as funding allows. The fleet manager will reach out to internal organizations to determine level of need and potential of additional funding.

GOAL 3.3: ALTERNATIVE FUEL VEHICLES

Ensure that 75% of light duty vehicle purchases consist of alternative fuel vehicles (AFV) by FY 2000 and thereafter.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

In recent years, BNL purchased 100% of its light duty vehicles as alternative fuel vehicles. Flex-fuel (E85) vehicles are normally purchased because they are readily available through the U.S. General Service Administration (GSA) and are less costly than converting vehicles to use compressed natural gas (CNG).

As stated in Goal 3.1, *Fleet Alternative Fuel Consumption*, the additional cost to a obtain replacement CNG vehicles compared to the same vehicle capable of using E85 is $12,500.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

BNL will examine potential outside funding opportunities that may allow for additional alternative fuel vehicle purchases. BNL will review all available replacement opportunities with GSA and continue to make business case decisions on the replacements within available funding.

BARRIERS

There are currently no anticipated barriers.

GOAL 3.4: FLEET INVENTORY REDUCTION

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

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL has developed a right-sizing plan to achieve an inventory of 259 vehicles. At this level, 253 vehicles are categorized as mission critical. BNL will have a reduction of 39 vehicles against the 2005 baseline representing 86% of all non-mission critical vehicles.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

By December 31, 2012 BNL's fleet will consist of 259 vehicles, of which 253 vehicles are classified as mission critical.

BARRIERS

No barriers identified.

GOAL 4: Water Use Efficiency and Management

GOAL 4.1: WATER INTENSITY REDUCTION

Reduce water intensity by 26% by FY 2020 from a FY 2007 baseline.

GOAL 4.2: WATER USE REDUCTION

Reduce water consumption of industrial, landscaping, and agricultural (ILA) water by 20% by FY 2020 from a FY 2010 baseline.

BNL has a long history of reducing water consumption even though water on Long Island is plentiful and inexpensive. Seventy-five percent of water used is recharged to groundwater via groundwater recharge basins. The water recharged is of potable water quality. Our minimal formal landscaping is compatible with the local climate and natural rainfall amounts are sufficient to support local flora.

WATER MANAGEMENT PLAN

BNL's Water Management Plan describes how BNL designs and operates the Laboratory's buildings and facilities to be sustainable and water efficient. It outlines our efforts to meet legislative requirements by implementing best-management practices, and details steps to reduce BNL's water consumption by 2%/yr (toward goals of 16% reduction by FY 2015 and 26% reduction by FY 2020 compared to a FY 2007 baseline).

BNL's water management program has been extremely successful, reducing our water consumption (measured in gallons per square foot of building area) by over 57% since 1999, and 10% since 2007. A significant decrease in once-through process cooling was achieved through operational improvements at the AGS. This reversed a recent trend whereby (1) operating additional research machines increased the demand for process cooling (e.g., start of Central Chilled Water Facility-Phase II operation) and (2) changes in the configuration of the potable-water system (well #12 went out of service, increasing Water Treatment Plant backwash cycles) had increased water use in FY 2009, FY 2010, and FY 2011.

Presently, we are implementing best-management practices (BMPs) as detailed in Section 2.2 of the Water Management Plan. Implementing water conservation is a significant economic challenge. Water is plentiful and inexpensive at BNL. The variable cost of producing water currently is about $0.39 per thousand gallons. Most water conservation measures are capital- and labor-intensive. We are always evaluating the return on investment of implementing additional BMPs. These BMPs have the potential to lower water consumption by more than 40 million gal/yr. Our ability to implement these capital-intensive measures depends upon obtaining additional benefits (such as replacing obsolete equipment, extending equipments' end-of-life, reduced maintenance costs, reducing waste water discharges to the sewage treatment plant, and increasing energy savings) and upon obtaining capital funding to install them (in completion with other priorities.

BNL is entering a period of significant programmatic growth. The National Synchrotron Light Source II (NSLS-II) is under construction. Its cooling will be provided by the new, major addition to BNL's Central Chilled Water Facility which includes a large cooling tower. This growth, along with the growth of other science programs, will increase BNL's water consumption. In fact, we estimate that the new NSLS-II alone will raise BNL's annual water usage by over 12%.

Finally, we emphasize that over 75% of BNL's water consumption is returned and recharged to groundwater at potable water quality. We believe that for practical purposes BNL's groundwater recharge fully meets the DOE's water management "recycling" or "non-consumptive" criteria (except for insignificant temperature changes). In an effort to increase the rate of on-site recharge, BNL has implemented a project to re-route the treated effluent from the sewage treatment plant from a surface water discharge to a groundwater recharge system. This project will also eliminate a potential source of trace metals contamination to the Peconic River and improve the quality of the river down-stream of BNL. Review of analytical data for the Sewage Treatment Plant effluent shows that the water quality meets all Federal and state groundwater quality standards. This change should result in an increase of 100 million gallons recharged locally versus off-site flow via the Peconic River.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL manages an effective water-reduction and conservation program for more than 20 years, illustrated in Figure 18 by the trend in annual potable (includes process) water usage.

Potable-water usage fell from almost 930 million gallons/year in FY 1999 to about 420 million gallons/year in FY 2012 (average of 1.15 million gallons per day), a reduction of 55%. When normalized by site growth (building area in gross square feet), BNL's annual water use intensity has decreased from 101 gallons per square foot to 91 gallons per square foot, a 10% water usage reduction since base-year 2007.

Final design for the Sewage Treatment Discharge Modification and site preparatory activities were completed in FY 2012.

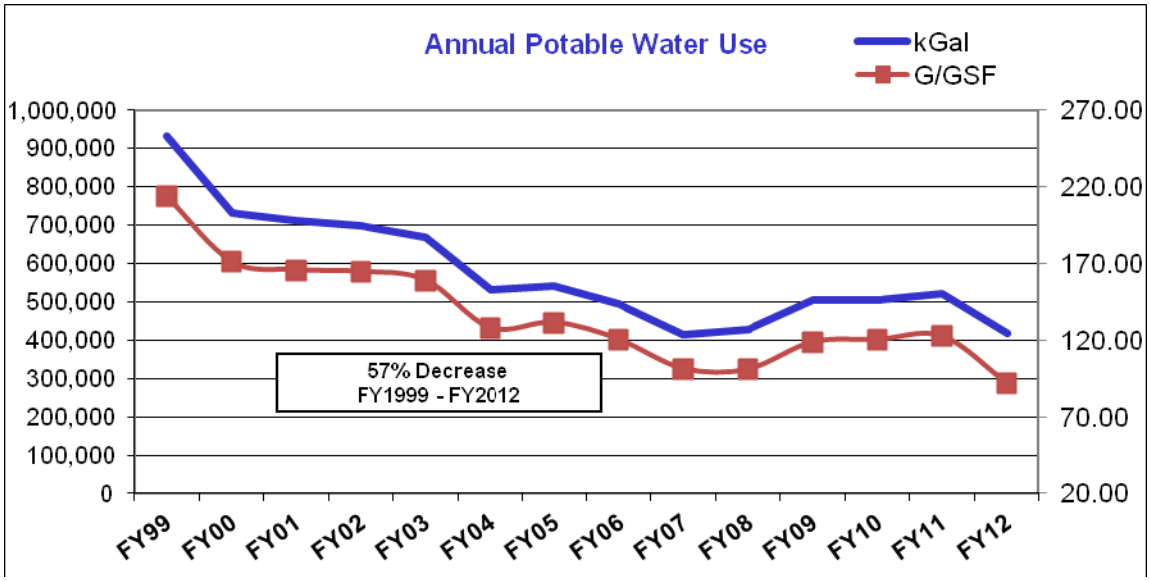


Figure 18. Annual potable water use (1999-2012).

Figure 19 depicts how BNL uses its potable water, and where it goes thereafter. Less than 10% is used for human consumption and sanitation. The majority of BNL's water production is spent for process cooling. This non-contact cooling water is used (once-through) to cool heat exchangers and returned to the groundwater. Water also is used to make up for evaporative, drift and blowdown losses from re-circulating cooling towers. Tower blow-down typically is discharged into sanitary or storm sewers, is treated, and ultimately returns to the groundwater.

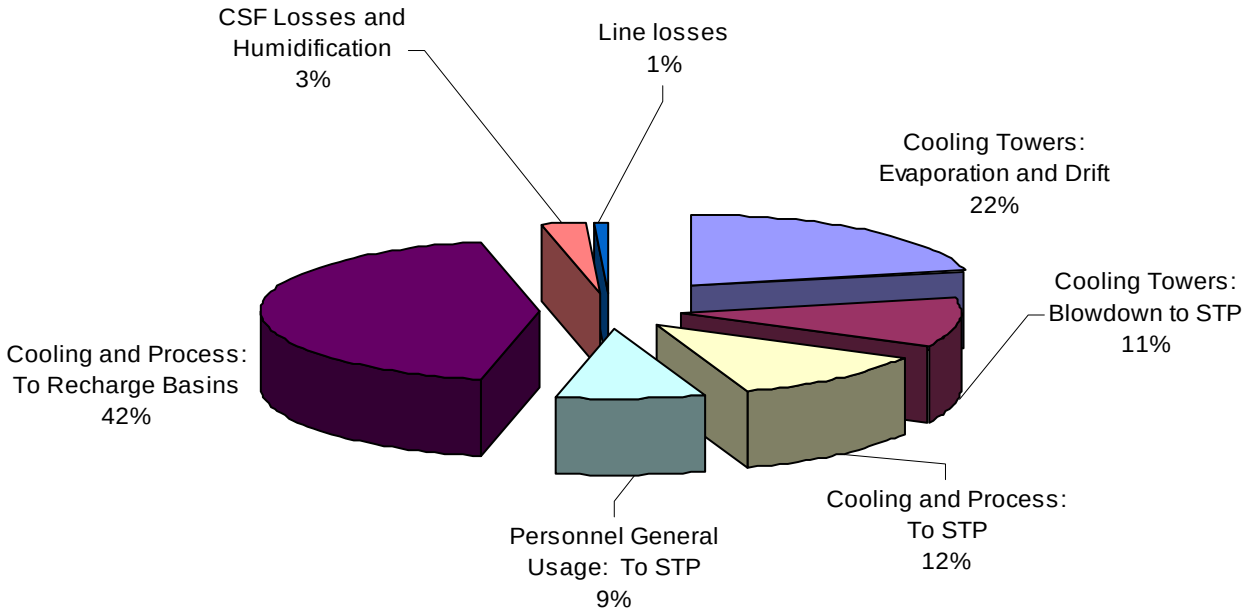


Figure 19. Annual potable water utilization.

The following paragraphs summarize BNL's past and present (ongoing) efforts in water conservation (best management practices); more details are available in BNL's Water Management Plan.

Public Information and Education Programs. BNL's water-related public information and education programs emphasize the excellent quality of BNL's potable water supply and seek to minimize employee's use of expensive, environmentally unfriendly bottled water.

Distribution System Audits/Metering. BNL periodically audits its water distribution system as part of infrastructure planning and utility reviews (e.g., 10-year Master Plans). BNL's utility engineers understand BNL's water system to be "tight" and relatively leak-free. Because of the plentiful supply and low cost of water at BNL, water meters are not available at most buildings or major process users. We bill one major process user for water.

Water-efficient Landscaping. BNL's minimal formal landscaping is compatible with the local climate and rainfall. BNL does not routinely irrigate lawns and landscape.

Toilets and Urinals. BNL currently specifies low consumption toilets and flushometers (1.6 gallons per flush (gpf) for toilets, 1.0 gpf for urinals) for new constructions, renovations, and maintenance.

Faucets and Showerheads. BNL specifies low-flow faucets and showerheads for new constructions, renovations, and maintenance.

Boiler/Steam Systems. BNL has a district steam-system and Central Steam Facility. Depending on the season, 75-85% of the steam exported from the facility returns as condensate. (This is excellent return for a large district steam-system and the condensate return conserves water and energy.)

Single-Pass Cooling Systems. BNL has reduced water flow through single-pass cooling systems that discharge to the sanitary sewer system. The marked success of these efforts is reflected in the 57% water reduction.

Cooling-tower Systems. To reduce water use in once-through cooling systems, BNL has 16 cooling towers with a flow rate of over 300 gpm. Many other smaller towers are located around the site. To maximize cooling efficiency and minimize water use, BNL controls the blowdown rates on the large towers to maintain the "cycles of concentration" between 4 and 5.

Water Reuse and Recycling. Over 75% of BNL's water consumption (except evaporation and drift at cooling towers) is recharged back to the ground (where the well water came from). All of BNL's process water (e.g., make-up and cooling) currently is obtained from the Laboratory's potable-water system and is accounted for in accordance with "Guidance for Water Goals in Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance".

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

Implementing additional water conservation will be a significant challenge economically. Water is plentiful and inexpensive at BNL. The variable cost of water production currently is about $0.39 per thousand gallons. Water conservation measures are capital- and labor-intensive. Nevertheless, there are possible conservation measures that could lower water consumption by over 40 million gallons/year (about 10%). Establishing these capital-intensive measures depends upon the ROI versus that of other projects. These strategies are listed below.

Distribution System Audits/Metering. We will continue to repair leaks as they become apparent, and prioritize needs for replacing the water mains. We will continue to seek funding to replace the transite (asbestos cement) water mains. Our Modernization Project Office's design criteria will be changed to install water meters on new buildings and when the water service pipes in buildings are modified (e.g., when backflow preventers [RPZ valves] are installed). A 2% savings is estimated due to fewer leaks and identifying water wastage via metering.

Estimated annual water savings:	4 million gallons
Estimated annual water-cost savings:	$1560
Total estimated cost:	N/A

Toilets and Urinals. We will install "BNL standard" high-efficiency utilization toilet and urinal fixtures and flushometers in new facilities, and will procure and install these high-efficiency fixtures and valves, as appropriate and as needed, during routine plumbing maintenance. We assume a 5% savings on human consumption and sanitation due to reduced water use.

Estimated annual water savings:	1.9 million gallons
Estimated annual water-cost savings:	$780
Total estimated cost:	$50,000 per year

Faucets and Showerheads. We plan to install "BNL standard" high-efficiency utilization (e.g., EPA WaterSense) sink/lavatory faucets and showerheads as appropriate during routine maintenance. We assume a 5% savings on human consumption and sanitation due to reduced water use.

Estimated annual water savings:	1.9 million gallons
Estimated annual water-cost savings:	$780
Total estimated cost:	$50,000 per year

Single-pass Cooling Systems. We requested FY 2011 operating funding to replace and/or modify cooling systems (total cooling capacity of about 200 tons) that use potable water, once-through cooling.

Estimated annual water savings:	21 million gallons
Estimated annual water-cost savings:	$8,200
Total estimated cost:	$660,000

Cooling Tower Systems. We requested FY 2011 operating funding to replace Building 488's cooling tower with a dry cooler.

Estimated annual water savings:	2.6 million gallons
Estimated annual water-cost savings:	$1,000
Total estimated cost:	$225,000

Cooling Tower Systems. We plan to survey and optimize the performance of the cooling tower performance to maximize the cycles of concentration and minimize water use.
We consider that the usage of blow down water can be lowered by 10%.

Estimated annual water savings:	10 million gallons
Estimated annual water-cost savings:	$3,900
Total estimated cost:	$225,000

Miscellaneous High Water-using Processes. Replacing and base-loading Well #12 (a low-iron well) will reduce the number of filter backwash cycles required at the Water Treatment Facility (WTF) by 50–70%, depending on sites' water consumption and the system's configuration. It also will replace lost production capability, increase the water system's reliability and the design fire flows, and reduce the costs of chemicals for other treatments.

Estimated annual water savings:	25 million gallons
Estimated annual water-cost savings:	$10,000
Total estimated cost:	$850,000

BNL continuously monitors and audits its water distribution piping network. Leaks are repaired as soon as they become evident. In 2011, BNL prepared a Utility Master Plan which includes projects to replace the most problematic transite and cast iron water mains.

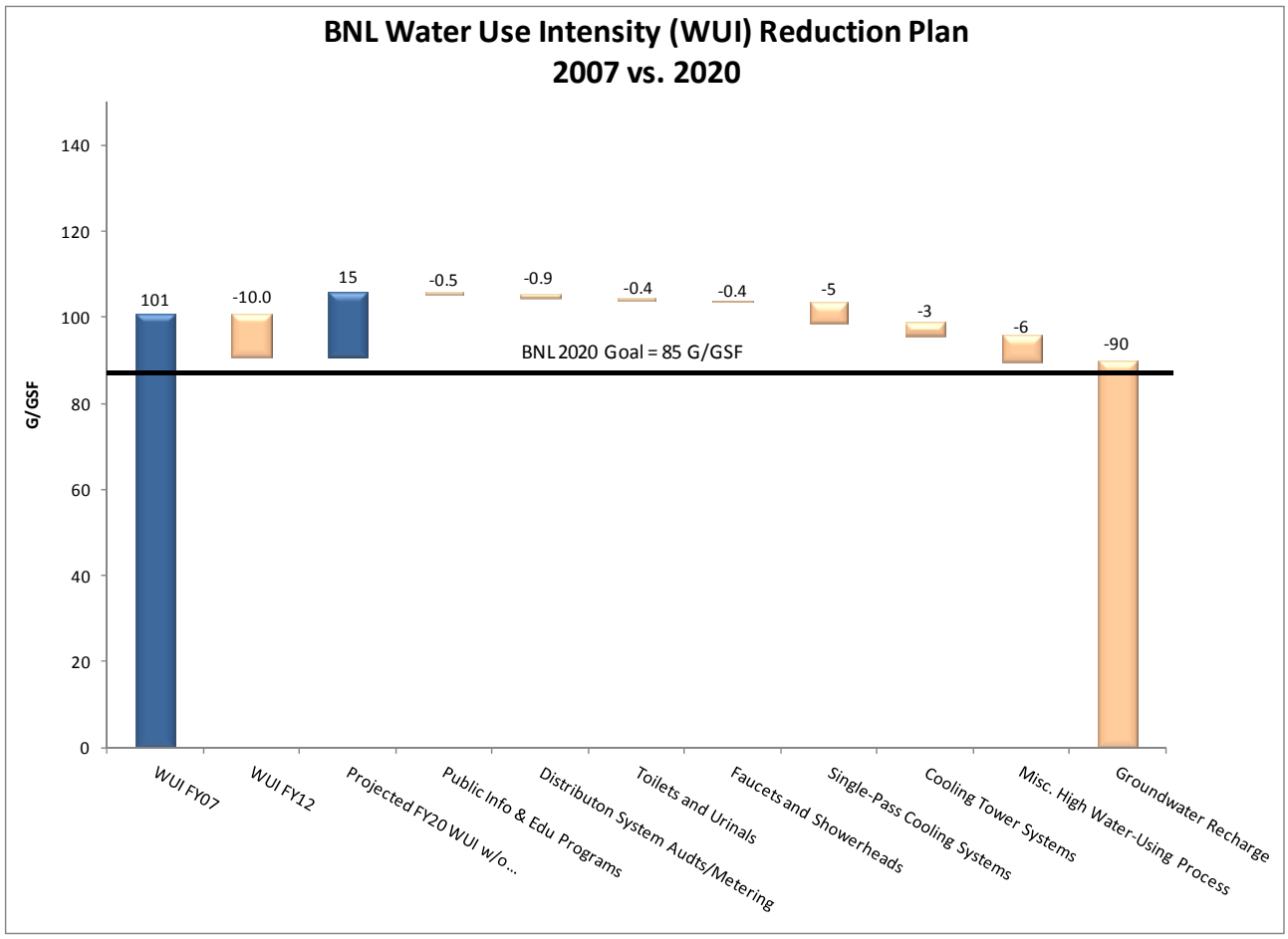
BNL is currently in its third year of funding replacement of faucets and flushometers with automatic low flow devices. This is often done while replacing worn-out plumbing fixtures. About $250,000 has been invested to date. We plan to spend an additional $50,000 in FY 2013.

BNL strives to replace air conditioning and process equipment that uses single pass (once-through) water cooling with new equipment that is air-cooled or uses closed loop cooling. This is usually done (1) at equipment upgrade, (2) to minimize heat exchanger fouling (maintenance) or (3) at end-of-life – all when practical, efficient and economical.

We continue to seek capital funding for the other water saving projects described herein. However, these water saving projects typically have very long paybacks. Capital funds have been allocated to projects with better returns-on-investment in science, risk-reduction and sustainability.

Figure 20 displays BNL's water use intensity including estimated increases as well as estimated reductions based on items described here and in our Water Management Plan.

The construction project is expected to go out for bid during the 2nd quarter of this FY with a scheduled completion by December 2013. This project is rated Low Risk and will be completed



approximately 9 months ahead of the NYSDEC milestone.

Figure 20. Water Use Intensity Reduction Plan 2007 vs. 2020.

Storm Water Management. BNL receives approximately 50 inches of precipitation annually. All precipitation runoff is managed on-site through a combination of local recharge drywells and a central storm water collection and recharge system. Numerous recharge basins and local grade discharges to wooded areas permit all storm water to recharge locally thereby minimizing impacts of BNL operations on the local hydrology. A secondary benefit of BNL's storm water management has been the creation of habitat for endemic amphibians including the New York State endangered Eastern Tiger Salamander. There are no surface water discharges or storm water conveyances for directing storm water away from the site. All construction activities are reviewed to ensure there are no impacts to existing storm water retention/recharge systems and created wildlife habitat. BNL's storm water management is in conformance with EISA Section 438.

BARRIERS

No known barriers at this time.

GOAL 5: Pollution Prevention and Waste Reduction

GOAL 5.1: NON-HAZARDOUS SOLID WASTE

Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris, by FY 2015.

GOAL 5.2: CONSTRUCTION AND DEMOLITION MATERIAL AND DEBRIS

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

Figure 21. Dumpster diving.

The 2011 Site Environmental Report, Section 2.3.4.4, describes BNL's Pollution Prevention and Waste Minimization programs in detail. As we identify new avenues for reuse or recycling, additional materials are diverted from the waste stream. During this past year, BNL completed the installation of a glycol recycling facility and we are now reprocessing and recycling our used glycol.

Over the past 11 years, BNL's annual diversion rate of non-hazardous solid waste ranged between 54% and 68%. During FY 2012, the recycling rate was approximately 57%.

During 2012, BNL conducted numerous "dumpster dives" *(Figure 21)* to assess the strength of our recycling program. Indications were that although the Lab has a robust recycling program, significant amounts of paper and cardboard were found in the waste stream. Review of our historical data indicated that on a tonnage basis, recycling rates for paper and cardboard were down 25% and 12%, respectively. Part of this volumetric decrease of paper could be attributable to the Lab's push on becoming more electronic file oriented, thereby generating less paper. However, as noted, significant amounts of paper were observed in the waste stream. It was also noted that in the past couple of years BNL's population has increased, with the growth of some Departments, and that these employees may have come from other geographic regions which didn't employ robust recycling and conservation measures. Other potential reasons for the down

trend may include poor training aids and new onsite vendor issues. As such, during calendar year 2013, the Lab will focus on educating employees on the Laboratory's recycling programs. New employee orientation videos and environmental computer based training videos will incorporate information on how employees can help increase recycling.

The Laboratory recycles 95% of construction, demolition, and wood debris. The materials are transported to a C&D transfer station where it is sorted and recycled by the vendor. Concrete and stone/brick demolition debris is stored on site and then converted via a concrete crusher to recycled concrete aggregate and used as road base or as underlay in parking areas. Since we use the crushed demolition debris on site, we are also saving transportation-related emissions as well as landfill space. BNL is also not purchasing recycled concrete aggregate (RCA) for these projects, thereby avoiding transportation and manufacturing of RCA and the associated large impact on the environment presented by these operations. Re-using C&D materials helps save the environment, and represents the essence of sustainability.

Approximately 99% of the Laboratory's paper has a minimum content of 30% post-consumer fiber. Certain specialty papers, such as photographic paper, do not meet these requirements. Setting printers and copiers to printing on both sides of the paper by default is left up to the discretion of the departments as the Information Technology Division does not have control over these peripherals. However, printing in duplex mode is strongly encouraged across the Laboratory.

BNL currently has two programs for diverting compostable materials. The first program, established in 2005, allows the composting of animal bedding used by the Medical Department that subsequently is mixed in with wood-composted debris to form mulch or soil conditioner. The second program removes organic matter from the on-site Cafeteria and deposits it into an inlet of the Sewage Treatment Plant to sustain appropriate food levels for the system's biological processes.

Since BNL's recycling efforts are programmatic (i.e., handled by Custodial Services and/or Property Management in all buildings), population change, construction, and D&D activities, may impact waste generation rates and volumes but should not impact the recycling diversion percentage rate. BNL is approaching the end of two major construction activities (NSLS-II and ISB). The completion of these construction activities will greatly impact (lessen) the volumetric generation of C&D materials. However, the recycling rates are not expected to change.

The Laboratory has a fully integrated Pest Management system and uses native plantings with no in-ground sprinkler systems. During 2012, BNL's Integrated Pest Management program was audited by the Cornell Cooperative Extension Program (a non-profit community education agency established in 1917) and found to be fully integrated and functioning.

Procedures to identify materials that cannot be cleared for unrestricted release have been developed and are documented in a lab-wide procedure entitled "Management of Moratorium and Suspension Encumbered Metals". This document establishes BNL's program for managing scrap metal in compliance with DOE directives. This procedure has been reviewed by DOE and has been presented as an example of good practice to other DOE laboratories.

The Laboratory is continually working with its scientists to find ways to minimize the use of toxic materials and substitute less or non-toxic surrogates in their procedures. Protocols and contracts

established by the Property Management Division have led to a streamlined, just-in-time method for ordering chemicals, which has minimize the Laboratory's footprint of on-site chemicals.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

The Laboratory continues to focus on its pollution prevention/waste minimization measures by evaluating metrics geared toward increasing its commitment to being a better steward of the environment.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

As discussed above, during calendar year 2013, BNL will focus on educating employees on the Laboratory's recycling programs. New employee orientation videos and environmental computer based training videos will incorporate information on how employees can help increase recycling.

BARRIERS

Based on the information presented above, BNL does not have reason to believe that we cannot meet DOE's expected goals of performance for pollution prevention and waste minimization.

GOAL 6: Sustainable Acquisition

GOAL 6.1: PROCUREMENTS

Ensure 95% of procurements each year meet sustainability requirements and include sustainable acquisition clause.

Figure 22. Sustainable acquisition.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

The requirements for Sustainable Acquisition are incorporated into all of BNL's Terms and Conditions issued by the Procurement and Property Management Division (PPM). Blanket purchase orders currently in place for items under Sustainable Acquisition include carpets, custodial cleaners, re-refined motor oil and office furniture. As in FY 2011, BNL was able to report that all contract actions for construction and custodial products and services met Sustainable Acquisition requirements in the FY 2012 Pollution Prevention Tracking System (PPTRS) reporting system.

The following categories were reported to meet the technical requirements for the FY 2012 priority product section in PPTRS:

- Construction- concrete
- Construction- lumber/wood
- Construction- paint
- Construction- carpet
- Construction- fiberboard, gypsum, panels, wallboard
- Construction- Water heater, heat pumps and energy recovery ventilators
- Custodial- toilet paper
- Custodial- floor care
- Custodial- carpet, glass, hand, multipurpose cleaners
- Custodial- Plastic trash bag

Approximately 99% of the paper purchased had a minimum content of 30% post-consumer fiber, which meets the recycled content requirements of the EPA's Comprehensive Procurement Guidelines. EPEAT registered or Energy Star qualified desktop and laptop computers were also purchased in FY 2012 where feasible. EPEAT standards have been approved for copiers, printers, and televisions. Energy Star settings are in place when the systems come in from the supplier.

Information concerning use of less toxic chemicals is listed in Goal 5, *Pollution Prevention and Waste Reduction.*

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

The following actions are planned for FY 2013 and beyond:

- Ensure requirements for Sustainable Acquisition are documented in the FY 2013 Pollution Prevention Tracking System (PPTRS).
- Ensure that the requirements for biobased products are incorporated into PPM's terms and conditions in FY 2013. The goal for biobased products is 60% by the end of FY 2013.
- Develop awareness training for green products for field deployed staff matrixed to Integrated Facility Management (IFM) complexes.
- Arrange green vendor fairs on site to encourage the use of green products.
- Provide technical assistance and education to the Laboratory community on the use and availability of green products and services.
- Increase communication on sustainable acquisition by preparing lessons learned and documenting success stories.

BARRIERS

The Laboratory does not have reason to believe that it cannot meet the goals of performance for sustainable acquisition in FY 2013.

GOAL 7: Electronic Stewardship and Data Centers

GOAL 7.1: DATA CENTER METERING

Ensure all data centers are metered to measure a monthly PUE (100% by FY 2015).

GOAL 7.2: MAXIMUM ANNUAL WEIGHTED AVERAGE PUE

Achieve a maximum annual weighted average Power Utilization Effectiveness (PUE) of 1.4 by FY 2015.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

BNL's Large Data center is a mixed use data center. It was indicated in the High Performance Sustainable Buildings Report, that some of the dedicated data center load is also serving nearby office areas. We are planning to sub-meter this office energy use to get a better understanding of overall data center infrastructure efficiency. Currently the Large Data Center's PUE_2 is estimated at 1.52, based on the High Performance Sustainable Buildings Report. The smaller administrative data center is categorized as a dedicated data center, with a current PUE_1 of 2.0.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

A consultant evaluated the energy efficiency of the large scientific data center with the goal to reduce the PUE (ratio of total power used to IT power) to below 1.4. In the smaller administrative data center, it was recommended to rearrange the rack in a hot aisle/cold aisle arraignment and update the computer room air conditioning (CRAC) units with an economizer coil option. During Over the Summer of 2012, student interns evaluated cold aisle containment in BNL data centers and determined implementation would greatly reduce data center cooling load.

BARRIERS

Economic justification and availability of funding are the primary impediments to meeting this goal.

GOAL 7.3: ELECTRONIC STEWARDSHIP

Ensure 100% of eligible PCs, laptops, and monitors have power management actively implemented and in use by FY 2012.

PERFORMANCE STATUS - FY 2012 PERFORMANCE

In December 2011, BNL implemented and enabled LANDesk power management throughout the laboratory where feasible. This control places monitors and computers into a low-power “sleep mode” after 20 minutes of inactivity. This resulted in our ability to exceed the requirements in the SSP for power management.

PLANS, ACTIONS AND PROJECTED PERFORMANCE - FY 2013 AND BEYOND

BNL will continue to evaluate the feasibility of extending this desktop computer-power management policy to other operating systems.

BARRIERS

No barriers have been identified.

GOAL 8: Agency Innovation and Government-wide Support

GOAL 8.1: AGENCY INNOVATION AND GOVERNMENT-WIDE SUPPORT

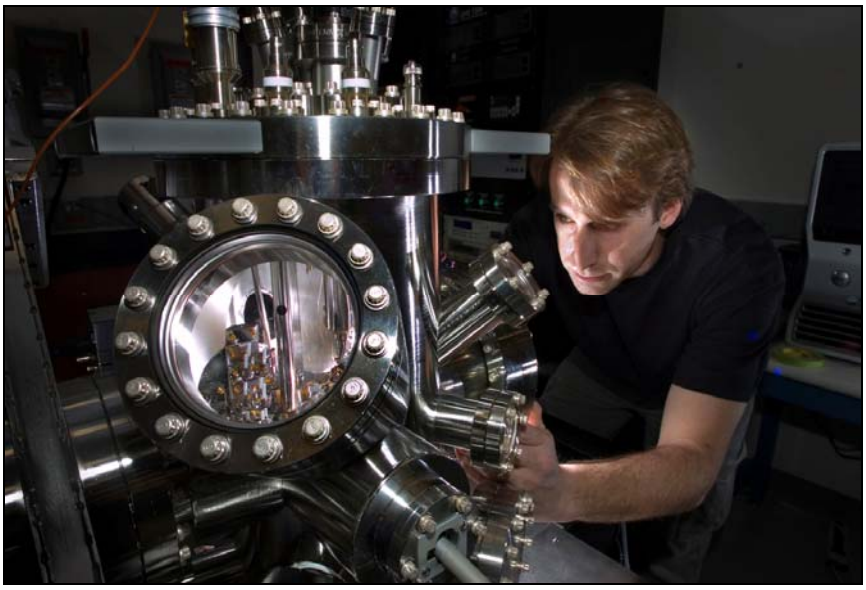


Figure 23. Energy research at the Center for Functional Nanomaterials.

Brookhaven National Laboratory is committed to leadership in sustainability through its management practices, stewardship of the BNL Campus, as well as its research and education programs. The Laboratory's efforts in sustainability are rooted in four guiding principles:

Energy Use and Management: Strive to be climate neutral through energy efficiency, conservation, low- carbon on-site generation, and strategic procurement of clean and renewable energy supply.

Built Environment: Lower the environmental impact of BNL's infrastructural elements and processes (e.g. waste management) by incorporating sustainability principles into master planning and the redevelopment of the BNL campus (campus design, new and renovated buildings, walkways, process systems, etc.).

Research: Leverage and enable BNL's strategic goals in research and development to transform BNL's environmental footprint, energy usage, built environment, and energy systems and supply, including mission-critical energy-intensive research facilities.

Community: Foster a culture of sustainability by integrating sustainability practices, principles, and objectives into our daily activities, core processes, and communications.

To date, these guiding principles have shaped the Sustainability Plan and the efforts of the Laboratory and yielded many beneficial programs. However, over the last three years, BNL has also begun to align strategic goals in energy research with the sustainability goals of the Laboratory, therein creating several innovative projects which promise to be transformative for both.

BNL's 10 Year Laboratory Plan describes the vision for the future of Brookhaven science programs. BNL's Annual Laboratory Plan outlines the actions it will undertake in each fiscal year in support of the BNL Strategy. As described in the BNL Strategic Plan, the laboratory's energy strategy has two main research thrusts, each with several core research areas.

Science and technology for the 21st century electric infrastructure

- Decarbonized generation
- Renewables integration
- Grid-scale storage
- Robust and effective distribution system

Sustainable chemical conversions

- Improved catalysts for synthesis of fuels by sustainable pathways
- Electro-catalysis chemical-electrical conversion in fuel cells
- Solar-to-fuel conversion through oxidation-reduction reactions

The first of these thrusts, Science and technology for the 21st century electric infrastructure, includes several projects that utilize BNL site infrastructure to develop leading research programs in "Smarter Grid" as well as building energy efficiency research. These efforts are conducted through a partnership between the Global and Regional Solutions Directorate and the Facilities and Maintenance Directorate of BNL.

BNL is addressing the four specific aspects of electric infrastructure needs that focus on the energy challenges and opportunities that are especially important in the Northeastern United States. These efforts all involve innovative research and development which is being deployed at the site level and in support of BNL sustainability goals. This work is also being conducted in partnership with an extensive network of collaborators and consortia in New York State, including the New York State Smart Grid Consortium, the New York Battery and Energy Storage Consortium – two prominent organizations in New York State wherein BNL plays key leaderships roles.

Two of the core research areas involve de-carbonized generation and renewables integration into the grid. The intermittent and geographically dispersed character of many renewable energy sources, e.g., wind and solar, offers challenges as their adoption becomes more widespread. These challenges have unique characteristics for the northeast, where electricity congestion and weather patterns exacerbate intermittency and grid integration.

BNL has lead the DOE complex in site transformation by actively pursuing the development of the 32 MW Long Island Solar Farm (LISF) on 195 acres on the east-end of the site. This is the largest solar photovoltaic plant east of the Mississippi and the sixth largest completed photovoltaic solar plant in the country. The construction of this plant was completed on November 1, 2011, when it "went live", delivering power to the grid. This project was conceived from the outset as a private-public partnership with an integrated research agenda, enabling the unique study of utility-scale photovoltaic plant performance and grid integration in the Northeast. BNL work is funded through DOE Energy Efficiency and Renewable Energy (EERE) Solar Energy Technologies Program. BNL is also developing an on-site solar test array with a design capacity of ~900kW, the largest in the DOE complex. This array will be completed in 2013 and integrated into BNL's electrical infrastructure. The BNL Test Array is funded through a Cooperative Research and Development

Agreement (CRADA) with BPSolar. The purpose of this array is to test advanced solar conversion electronics (inverters) and advanced electrical conversion topologies, study grid integration on distribution circuits, and to test advanced power quality (DVAR) features of advanced inverters, presently incorporated in inverters that are now entering production. This work is being done in partnership with BPSolar, Long Island Power Authority, and the Electric Power Research Institute (EPRI), among others.

Coupled with this, BNL is utilizing its electricity distribution system to develop a micro-grid test-bed in support of its research in effective distribution system. The first phase of this development will also be completed in 2013. This project involves working with a small start-up company, Smart Energy Instruments (SEI), who has developed advanced smart grid sensors for the distribution layer, deploying these sensors on the BNL electricity distribution system to test their capabilities, and ultimately integrating these into energy management functions of the distribution system. The initial phases of this work are funded through BNL Laboratory Directed Research and Development Funds. As an important part of this research, BNL is also working with a small software developer, Electrical Distribution, Design, Inc (EDD) to test and validate leading simulation tools for dynamic electricity systems modeling of the distribution layer funded. One aspect of this will be the development of a detailed representation of the BNL distribution system to model time-resolved power flows and electricity utilization. In FY 2012, BNL engineering research staff used the EDD Distribution Engineering Workstation Software and worked with Orange and Rockland Utility (ORU) to perform simulations in support of efforts to manage load-growth on the ORU system.

In 2013, the detailed model of the BNL system will be used to study reactive power losses in the BNL distribution system and develop strategies that could reduce these losses. The SEI sensors will be used to monitor power quality across the Laboratory, electrical transients, reactive power flows, output from the solar array (power quality and quantity), as well as phase imbalance and other functions. These measurements are vital input to the BNL distribution system modeling.

The solar array, along with the BNL microgrid project, is central to BNL's vision for a Northeast Solar Energy Research Center (NSERC), which will serve as a focal point for research and industrial involvement in addressing systems performance and grid-integration issues. To this end, this work is being conducted in partnership with Smart Energy Instruments, Orange and Rockland Utility, Virginia Tech, and Electrical Distribution Design, Inc.

BNL is also working on the development and implementation of advanced building controls algorithms to "continuously tune" buildings in order to sustain peak energy efficiency and to enable the reduction of energy consumption upon request, i.e. demand response. The first phase will utilize a set of BNL buildings for research, test and demonstration purposes. The goal is to deploy energy monitors and advanced software, utilizing existing BNL building HVAC controls, to document the potential energy savings that can be realized through closed-loop control systems. If successful, this effort will lower BNL's energy use as well as potentially reduce maintenance costs, through automation.

III. CLIMATE CHANGE ADAPTATION

BNL has not conducted a systematic climate change impact study nor has it developed any concrete adaptation plans for the BNL site to date. This past year, the site experienced the effects of a record hurricane, Sandy, that affected most of the Northeast. Most utility systems remained operational during this event. The greatest effects were those of downed trees and minor building envelope issues. Significant upfront planning was initiated for this storm and several previous severe weather events to better understand building vulnerabilities and the effect on the science mission.

Another area of focus is how the regional electric grids function and perform during severe weather events and other major events. Through the Governor's Regional Economic Development Initiative, initial support has been provided for Smarter Electric Grid Research, Development, Demonstration and Deployment Center (SGRID^3), a Center that brings Stony Brook University's Advanced Energy Research and Technology Center (AERTC) resources together with Brookhaven National Laboratory (BNL) to create two leading edge facilities that will establish New York as the undisputed leader in "smarter grid" systems design and control and technology development and deployment. Building SGRID^3 will provide a laboratory for proving existing technologies and developing needed technologies, and for improving operational effectiveness.

IV. HIGH ENERGY MISSION-SPECIFIC FACILITIES (HEMSF)

This section provides an overview of the four identified HEMSF facilities at BNL: the Center for Functional Nanomaterials (CFN), the National Synchrotron Light Source (NSLS), the National Synchrotron Light Source II (NSLS-II), and the Relativistic Heavy Ion Collider (RHIC). These descriptions include the scientific equipment, buildings and the associated support systems facilities that comprise the HEMSF.

While we believe the GHG reduction target will be achieved, BNL remains somewhat concerned with the impact that facilities growth will have on our GHG reduction targets and water usage. NSLS-II and other HEMSF facilities will increase our load both in energy consumption, greenhouse gas, and water usage. However, significant progress has been made, with the assistance of BHSO, on moving the UESC project forward. The first phase of work focusing mostly on building features and controls for lighting, steam, heating, and cooling is planned to commence in early 2013. A preliminary feasibility study was completed this year on siting a combined heat and power (CHP) plant for BNL. Initial indications are positive. This year, BNL will invest in a detailed CHP and biomass study to solidify the concept and confirm feasibility to incorporate gasification of local wood waste streams.

CENTER FOR FUNCTIONAL NANOMATERIALS

The Center for Functional Nanomaterials (CFN) at Brookhaven National Laboratory provides state-of-the-art capabilities for the fabrication and study of nanoscale materials, with an emphasis on atomic-level tailoring to achieve desired properties and functions. The CFN is a science-based user facility, simultaneously developing strong scientific programs while offering broad access to its capabilities and collaboration through an active user program. The overarching scientific theme of the CFN is the development and understanding of nanoscale materials that address the Nations' challenges in energy security, consistent with the DOE mission.

Figure 24. Center for Functional Nanomaterials.

The CFN is one of five nanoscale science research centers (DOE NSRCs) across the U.S. funded by the DOE's Office of Science. The CFN supports the Laboratory's goal of leadership in the development of advanced materials and processes for selected energy applications.

As a premier user facility for conducting interdisciplinary nanoscience research, the CFN serves as a focal point and enabler of advanced materials study in the northeastern United States.

Together with the NSLS and, in the future, NSLS-II, these facilities will complement each other to facilitate the nanoscale revolution. The synergy among these world-class machines, with BNL's own scientific staff working collaboratively with university, industrial and government laboratory researchers, offers unique opportunities for breakthroughs in energy research.

The science at the CFN is organized around these five scientific themes:

- Electronic Nanomaterials
- Interface Science and Catalysis
- Electron Microscopy
- Soft and Biological Materials
- Theory and Computation

The experimental capabilities at the CFN are arranged into seven laboratory facilities:

- Synthesis and Characterization
- Advanced Optics
- Nanofabrication
- Proximal Probes
- Electron Microscopy
- Theory and Computation
- CFN End stations at NSL

Access to the user program at the CFN is through a simple, peer-reviewed proposal process with a call for proposals that takes place three times per year. This facility is not designated in FIMS as "excluded".

NATIONAL SYNCHROTRON LIGHT SOURCE I (NSLS-I)

As a national user research facility funded by the U.S. DOE's Office of Science, the NSLS provides intense beams of infrared, ultraviolet, and x-ray light for basic and applied research in physics, chemistry, medicine, geophysics, environmental, and materials sciences, and allows scientists to examine materials and processes at a scale that is not possible at other types of research labs or facilities. The NSLS has approximately 2,100 visiting scientists per year from more than 400 national and international universities, laboratories, and other research institutions.

Figure 25. National Synchrotron Light Source.

Synchrotron radiation facilities provide unique and powerful tools for characterizing the temporal and spatial evolution of working catalysts. The properties of catalysts can be studied using a wide range of x-ray techniques, such as x-ray powder and/or single-crystal diffraction, small-angle x-ray scattering, and many x-ray spectroscopy methods.

Condensed matter physics deals with the macroscopic physical properties of matter. In particular, it is concerned with "condensed" phases, which occur when the number of constituents in a system is extremely large and the interactions between the constituents are strong. The most familiar

examples of condensed phases are solids and liquids, but more exotic condensed phases include the superfluid and the Bose-Einstein condensate found in certain atomic systems at very low temperatures, superconductivity, and the magnetic phases of spins on atomic lattices.

One major thrust of biological and soft-matter research at synchrotron facilities is protein crystallography, which uses x-rays to see the crystal structure of proteins and other biological molecules. Other research focuses on using x-rays to image tissue and cells, and to “watch” biological processes that occur on very short time scales, such as protein folding. The information learned from these fundamental studies is used to design drugs and treatments for disease, to predict and detect disease, and to understand the vast array of biological processes that govern life. This facility is designated in FIMS as “excluded”.

NATIONAL SYNCHROTRON LIGHT SOURCE II (NSLS-II)

The purpose of NSLS-II is to provide extremely bright x-rays for basic and applied research in biology and medicine, materials and chemical sciences, geosciences and environmental sciences, as well as nanoscience.

Figure 26. Constructed Ring Building of the new NSLS-II Facility. Picture taken September 2011.

As the successor to NSLS, NSLS-II is scheduled to be operating by 2015 as the world’s most advanced synchrotron light source. The new facility will have extremely high brightness and flux, exceptional beam stability, and a suite of advanced instruments, optics, and detectors. Taking advantage of these new capabilities, scientists will be able to image materials with nanoscale resolution and determine chemical activity in fine detail.

The NSLS-II will accommodate more than 60 beamlines using 27 straight sections for insertion-device sources and 31 bending-magnet or three-pole-wiggler sources, with additional beamlines possible through canted insertion devices and multiple branches.

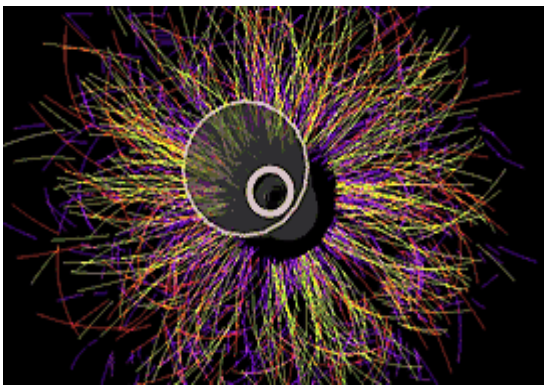
Six beamlines were selected in 2008 and are now funded within the NSLS-II project. These project beamlines encompass research programs in inelastic x-ray scattering, hard x-ray nanoprobe, coherent hard x-ray scattering, coherent soft x-ray scattering and polarization, submicron

resolution x-ray spectroscopy, and x-ray powder diffraction. This facility is designated in FIMS as “excluded”.

RELATIVISTIC HEAVY ION COLLIDER (RHIC)

RHIC is the first machine in the world capable of colliding heavy ions, which are atoms where the outer cloud of electrons has been removed. RHIC primarily uses ions of gold, one of the heaviest common elements, because its nucleus is densely packed with particles.

RHIC collides two beams of gold ions head-on when they're traveling at nearly the speed of light (what physicists call relativistic speeds). The beams travel in opposite directions around RHIC's 2.4-mile, two-lane "racetrack." At six intersections, the lanes cross, leading to an intersection. When ions collide at such high speeds fascinating things happen.



Figures 27 and 28. RHIC Ring and Collision observed at STAR.

Research at RHIC can be applied in nuclear physics (the study of atomic nuclei), particle physics (the study of the atom's constituents), astrophysics (the study of stars and planets), condensed matter physics (the science of solid matter) and cosmology (the study of the universe).

The following experiments and collaborations take place at RHIC: PHENIX, STAR, pp2pp, Electron Ion Collider Collaboration, and Zero degree Calorimeter.

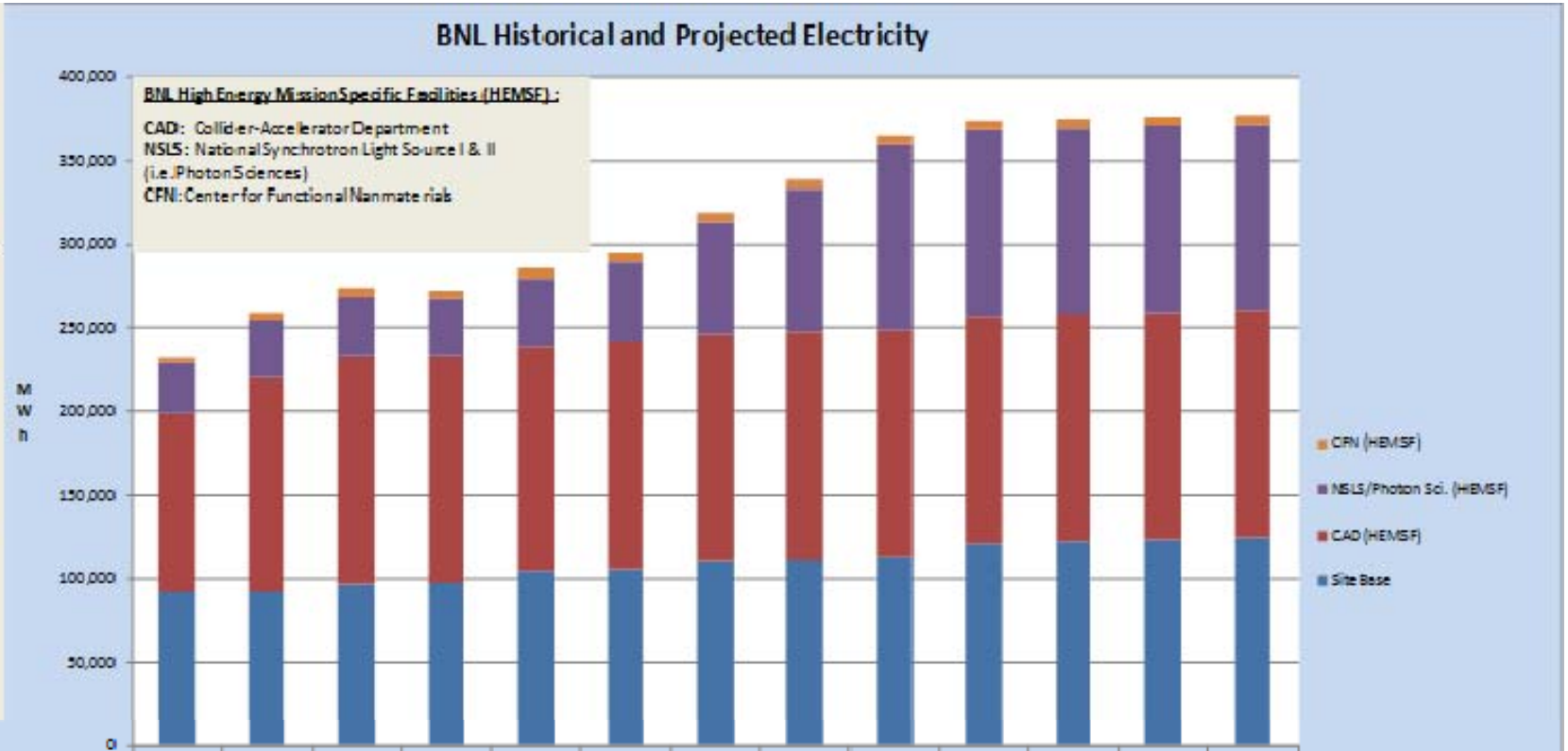
This facility is designated in FIMS as “excluded”.

HISTORICAL AND PROJECTED ELECTRICITY USAGE WITH HEMSF BREAKDOWN

Total purchased electricity is estimated to increase over 60% by 2020 compared to 2008 levels.

BNL has developed a preliminary plan in the SSP to reduce/offest the estimated increase in Greenhouse Gas (GHG) emittions to meet or exceed the 28% reduction target by 2020 as compared to the base year of 2008, for a total reduction/offset of ~115%.

BNL's sustainability initiatiive will require major infrastructure investments.



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CFN (HEMSF)	3,000	4,500	5,100	5,300	5,398	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400
NSLS/Photon Sci. (HEMSF)	30,665	33,313	35,192	34,146	41,708	48,164	67,560	85,848	111,778	111,778	111,778	111,778	111,778
CAD (HEMSF)	107,078	129,248	136,687	136,626	133,560	135,200	135,200	135,200	135,200	135,200	135,200	135,200	135,200
Site Base	92,304	91,902	96,923	96,991	104,826	106,030	110,892	112,074	113,257	121,798	122,981	124,163	125,346

V. BUDGETS AND FUNDING

BNL's Facilities and Infrastructure Mission Readiness Program provides the facility and infrastructure strategic planners with critical key information focused on capability and reliability requirements for current, committed, and anticipated research missions for the Laboratory. This knowledge, when coupled with infrastructure and facility capacity information, facilitates gap identification and solution development. Sustainability needs are part of that gap analysis to ensure we not only meet DOE goals but ensure our facilities remain sustainable and ready to meet mission needs. Once gaps are identified, those relating to facilities are defined in discrete projects for prioritization and execution.

Funding for the facility projects portion of BNL's Sustainability program are provided through the Project Planning, Programming and Budgeting Process (3PBP). The process was developed to assist in meeting the key objectives of DOE and Laboratory senior management.

The 3PBP

- Provides an integrated, prioritized list of projects for accomplishment in the current fiscal year and the two successive years, forming a three-year rolling plan
- Provides an integrated, prioritized list of projects to be incorporated in the Laboratory budget submission to DOE for the Budget Year (CY+2)
- Identifies key unfunded projects and prompts development of near-term measures to reduce associated risks
- Develops a backlog list for input to strategic planning and decision-making processes
- Ensures stakeholders' concerns are considered in the resources allocation process
- Provides a mechanism to link the Laboratory's goals with project-approval decisions
- Ensures that decisions regarding prioritization and allocation of Laboratory resources are made with the most current information and are well-documented
- Provides a mechanism to identify time critical issues that can impact Laboratory mission readiness capabilities
- Allows flexibility for introduction of new priorities throughout the year
- Provides a mechanism for conversion of project priorities to budget documents
- Provides a mechanism for conversion of project priorities to the Annual Laboratory Plan.

The development of the project list discussed above starts with the collection of all the projects needs that have been identified. This collection of needs is called the "Consolidated Unfunded Requirements List" (CURL). Each project is assigned to a Level 1 Manager who champions the project, and independent groups evaluate the risk/benefit of the project and relation to BNL's overall strategic objective. Sustainability projects are championed by the ALD for Facilities and Operations who evaluates the goals of the sustainability program, looks for alternate opportunities

for funding, including the potential synergies with other projects, and then presents those to the BNL Policy Council. The Council's other members represent the projects they champion, so the most effective overall solution of meeting all mission reediness needs can be selected, keeping the budgetary constraints determined based on current budgets and DOE guidance on future budgets in mind.

BNL anticipates initiation of a Utility Energy Service Contract (UESC) in early 2013. The project has been carefully crafted to ensure the best outcome in terms of realized energy savings while enhancing infrastructure needs. BNL has expended considerable effort developing this UESC and is confident it will be successful. It includes a robust Performance Assurance Plan that is based on utilizing all of the cost savings to cover the financing costs of the project. Operating and maintenance budgets have been developed to ensure sufficient project management and maintenance issues are addressed.

VI. INSPECTOR GENERAL REPORT ON OPPORTUNITIES FOR ENERGY SAVINGS AT DOE FACILITIES

Recommendation 1: Require Federal Site Managers to evaluate opportunities to more effectively utilize facility evaluations and electricity metering to decrease energy costs and improve operations in their facilities.

Action Plan: As stated in other sections, Facility Energy Use Evaluations (Energy Audits) of building energy systems will continue to be used to identify opportunities for energy conservation. The findings will be used to develop policies on operation and equipment needs. Starting in 2012, these audits are being performed in conjunction with our condition assessment surveys to reduce costs and administrative oversight, with actual savings of approximately $45,000/year.

BNL has completed 100% of the required evaluations over the last four years and has plans to continue to audit at least 25% of the site each year.

Recommendation 2: Require Federal Site Managers to prioritize the most cost-effective projects identified by facility evaluations and electricity metering, and implement these projects in a timely manner.

Action Plan: All cost effective projects identified in the Facility Energy Assessments are/will be included in the CEDR in prioritized order.

Recommendation 3: Require Federal Site Managers to consider opportunities to streamline the performance and reporting of required facility evaluations in order to conserve scarce resources.

Action Plan: As stated above, all cost effective projects identified in the Facility Energy Assessments are/will be included in the CEDR in prioritized order.

Recommendation 4: Require Federal Site Managers to implement best practices related to billing for electricity usage to the maximum extent practicable.

Action Plan: BNL has a long and successful history of metering and managing energy use. Electricity and chilled water have been metered and billed to individual departments for decades and have yielded substantial cost savings and energy reductions. Currently over 97% of BNL's electricity and 99% of chilled water usage are billed directly to departments and buildings that consume the energy. Virtually all of these meters are "advanced".

Given BNL's success with energy metering and billing, we continue to enhance and expand the system and are working to complete the steam metering and billing system in the near future.

APPENDICES

APPENDIX A – ENERGY CONSUMING EXCLUDED BUILDINGS AND TRAILERS LIST

APPENDIX B – SUSTAINABILITY HIGHLIGHTS *(OPTIONAL, NOT SUBMITTED)*

APPENDIX C – GOAL SUMMARY TABLE

APPENDIX D – CONSOLIDATED ENERGY DATA REPORT (CEDR) FOR FY2012 ACTIVITIES *(FILE PROVIDED SEPARATELY)*

APPENDIX E – BROOKHAVEN NATIONAL LABORATORY METERING PLAN JULY 2012 UPDATE

APPENDIX F – LIST OF ACRONYMS AND ABBREVIATIONS