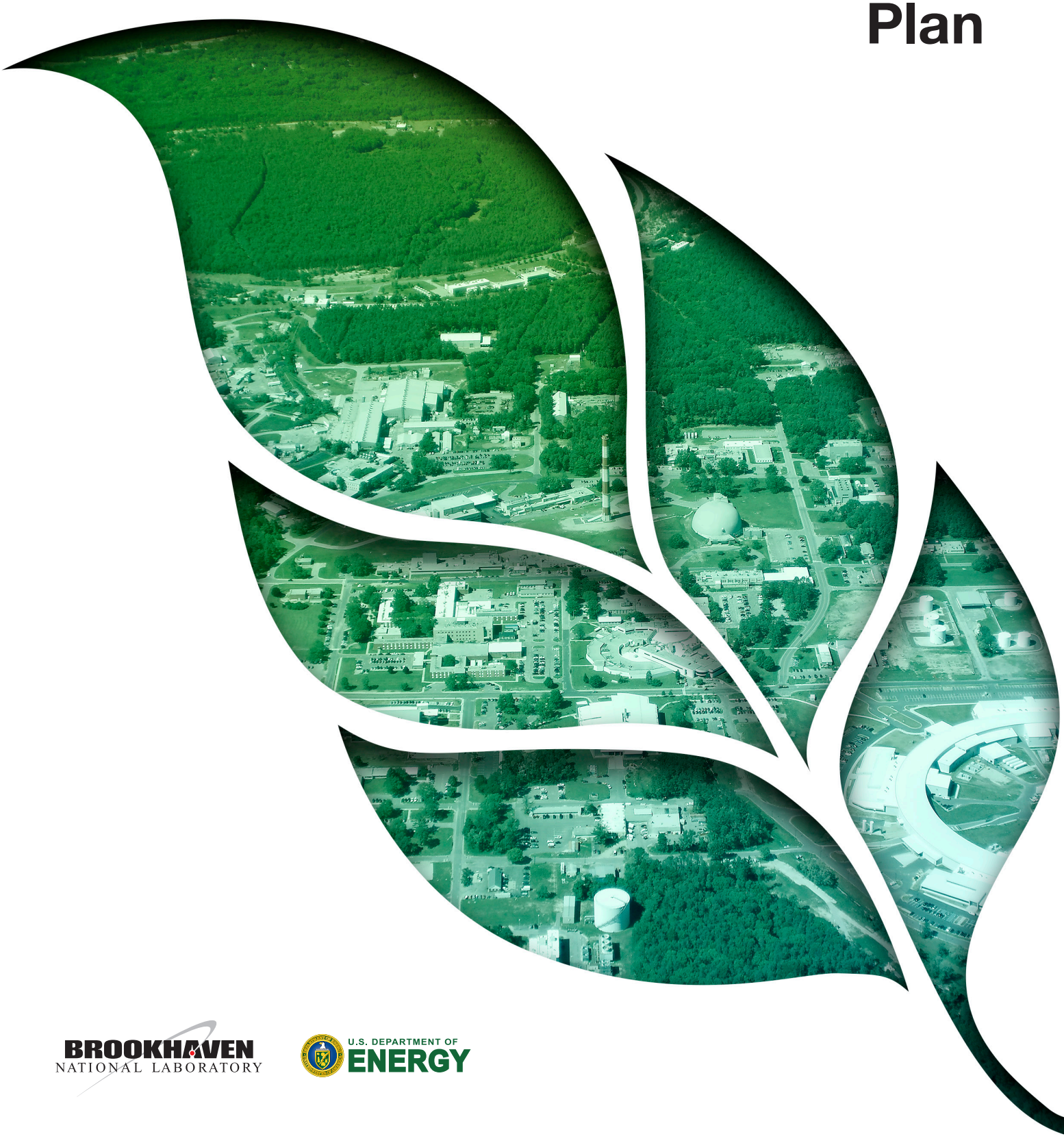
BROOKHAVEN NATIONAL LABORATORY

FY 2020 Site Sustainability Plan



BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

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I. Executive Summary and Executive Summary Table

Brookhaven Science Associates (BSA) is pleased to submit this annual Site Sustainability Plan for Brookhaven National Laboratory (BNL). Effectively managing such a large, diverse portfolio of programs takes many committed individuals working towards a common goal. This document is the work of a large cross-functional team of BSA employees both within the science directorates as well as the support or operations directorates.

BNL is operated and managed for the Department of Energy Office of Science (DOE-SC) by BSA, a partnership formed by Stony Brook University (SBU) and Battelle Memorial Institute. BNL is staffed by over 2,600 research and support employees and hosts an even greater number of facility users, guest researchers, and scientists annually. The Laboratory operates from an extensive campus located in Upton, New York, on 5,320 acres with approximately 4.9 million gross square feet (gsf) of space in over 300 buildings.

BNL conceptualizes, designs, builds, and operates major scientific facilities and makes them available to university, industry, and government researchers in support of the SC 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 to demonstrate 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 (SSP) to help ensure a successful future for our nation.

The Laboratory's efforts in sustainability have been consistent over the last several years and they focus on four broad principles:

1. Striving to be climate neutral through reducing energy use and effective energy 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 northeastern region; and
4. Fostering a culture of sustainability with our employees and our community.

The Laboratory remains strongly committed to supporting and achieving the targets in the DOE Strategic Sustainability Performance Plan (SSPP). Leadership in sustainability is demonstrated through the Laboratory's management practices, stewardship of the BNL campus, as well as our research and education programs. The efforts in sustainability are communicated widely across the Laboratory, and the Senior Leadership team remains actively engaged.

BNL's energy management program continues to be the centerpiece of our Sustainability program. We continue to maintain solid relationships with local utility providers ensuring cost effective power rates for operating the energy intensive user facilities and general infrastructure. BNL collaborates 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.

BNL continues to host the Long Island Solar Farm (LISF), a solar photovoltaic (PV) power plant, developed through a collaboration that included BP Solar, the Long Island Power Authority (LIPA), and DOE. The LISF, located on the BNL site, began delivering power to the LIPA grid in November 2011. The LISF is made up of 164,312 PV panels and can produce up to 32 MW of electricity.

Additionally, the Laboratory has developed the Northeast Solar Energy Research Center (NSERC) on its campus that serves as a solar energy research and test facility for the solar industry. The mission of the NSERC is to support the expansion of solar power by providing high-quality data, field-testing, analyses, and solar energy expertise to address technical, economic, environmental, and policy issues facing solar power deployment in northeastern climates. The NSERC will be a proving ground for BNL and our industrial partners to test new solar technologies, including electrical inverters, storage devices, and solar modules, which effectively adds solar energy research to the user facility portfolio of BNL.

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. Staff members from the BNL Environment, Biology, Nuclear Science, and Nonproliferation (EBNN) Directorate, Facilities & Operations (F&O) Directorate, Information Technology Division (ITD), and the DOE Brookhaven Site Office (BHSO) have been instrumental in preparing our research agenda and developing a plan to bring it to fruition.

The Comprehensive Scorecard illustrates the areas we've been extremely successful, and they include compliance with the Guiding Principles (GPs) of High Performance Sustainable Buildings (HPSB), construction and demolition recycling, fleet management, and sustainable purchasing.

The Laboratory has made significant progress this year in meeting the goals of the SSPP. We have challenges that we are working on creative solutions to overcome. This coming year we will be maintaining focus on those areas that are preforming well and will be concentrating on making improvements in those areas that are not on track to meeting the requirements, including evaluating zero emission buildings, GHG emissions, as well as data center efficiencies.

Sustainability remains an important focus for BNL. BSA and BHSO work collaboratively on these efforts. We continue with our quarterly meetings to ensure that we are on track to meet the goals as well as to discuss challenges in meeting these goals. This is a marathon, not a sprint and requires a strong team effort to ensure that we continue to press forward in doing our part to protect the environment. We are on a very good path.

A copy of the Executive Summary Table is provided below, highlighting plans for anticipated performance towards DOE targets as a guide.

Prior DOE Goal	*Current Performance Status*	*2 Year Performance & Plans*	*5 Year Performance & Plans*	*10 Year Performance & Plans*
Energy Management				
30% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2015 from a FY 2003 baseline and 1.0% YOY thereafter.	-2.7%	Target Goal: -4% Continued efforts for Temperature Set-back. Initiate a second UESC	-8% ~4% reduction from UESC II	Maintain performance of UESC projects and continued emphasis on temperature set-back
EISA Section 432 continuous (4- year cycle) energy and water evaluations.	0 Findings	Continue 4-year evaluation cycle	Continue 4-year evaluation cycle	Continue 4-year evaluation cycle
Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate.	100% of Electric 100% of Natural Gas 100% Chilled Water 92% of Steam use ~40% of Water use	Increase water use metering to 45%. New SUSC facility will include metering for all	Increase Steam metering to 95% and Water to >50% Require all new buildings and facilities to be metered	Increase Steam metering to 98% and Water use to >70% Require all new buildings and facilities to be metered
Water Management				
20% potable water intensity (Gal per gross square foot) reduction by FY 2015 from a FY 2007 baseline and 0.5% YOY thereafter.	-48.4%	Continued diligence in identifying leaks and waste	-50% or greater. Will investigate non-evaporative cooling where feasible. Reconstruction of Well House No. 12 and reduction of Water Treatment Plant filter back-wash cycles could reduce BNL's water usage by 3% to 5%	Continue efforts to identify cost-effective non-evaporative cooling options
Non-potable freshwater consumption (Gal) reduction of industrial, landscaping, and	N/A	N/A	N/A	N/A

Prior DOE Goal	*Current Performance Status*	*2 Year Performance & Plans*	*5 Year Performance & Plans*	*10 Year Performance & Plans*
agricultural (ILA). YOY reduction; no set target.				
Waste Management				
Reduce at least 50% of non- hazardous solid waste, excluding construction and demolition debris, sent to treatment and disposal facilities.	70%	Re-evaluate waste-to-energy option for MSW disposal	Add food composting to the recycling program	Continue to seek options for diverting MSW from landfills
Reduce construction and demolition materials and debris sent to treatment and disposal facilities. YOY reduction; no set target.	68%	Evaluate sending daily C&D from small projects to recycle center verses landfill. If successful, all C&D will be recycled	Maintain program	Maintain program
Fleet Management				
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline and 2.0 % YOY thereafter.		Continue replacing petroleum fueled vehicles with alternative fuel vehicles, and regularly replacing old vehicles with newer, more efficient vehicles	Continue replacing petroleum fueled vehicles with alternative fuel vehicles, and regularly replacing old vehicles with newer, more efficient vehicles	Continue replacing petroleum fueled vehicles with alternative fuel vehicles, and regularly replacing old vehicles with newer, more efficient vehicles
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter.		Continue to replace gasoline vehicles with alternate fuel and electric vehicles and look for opportunities for other types of alternative fuels	Continue to replace gasoline vehicles with alternate fuel and electric vehicles and look for opportunities for other types of alternative fuels	Continue to replace gasoline vehicles with alternate fuel and electric vehicles and look for opportunities for other types of alternative fuels
75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV).		Acquire future vehicles as alternative fuel whenever possible	Acquire future vehicles as alternative fuel whenever possible	Acquire future vehicles as alternative fuel whenever possible

Prior DOE Goal	*Current Performance Status*	*2 Year Performance & Plans*	*5 Year Performance & Plans*	*10 Year Performance & Plans*
Clean & Renewable Energy				
"Renewable Electric Energy" requires that renewable electric energy account for not less than 7.5% of a total agency electric consumption by FY 2013 and each year thereafter.	8.8% for Renewable Goal. Over 1 million kWh generated with Solar PV at NSERC 5.9% For Clean Energy Goal	Continued operation of the NSERC facility, as well as REC purchases as necessary to meet both the Renewable and Clean Energy Goals	Continued operation of the NSERC facility, as well as REC purchases as necessary to meet both the Renewable and Clean Energy Goals	Continued operation of the NSERC facility, as well as REC purchases as necessary to meet both the Renewable and Clean Energy Goals
Continue to increase non-electric thermal usage. YOY increase; no set target but an indicator in the OMB scorecard.	None	Investigate solar thermal applications for SUSC	Investigate solar thermal applications for Discovery Park and any new facilities	Investigate solar thermal applications for all new buildings and facilities including EIC
Green Buildings				
At least 15% (by count) of owned existing buildings to be compliant with the *revised* Guiding Principles for HPSB by FY 2020, with annual progress thereafter.	19.5%	The new SUSC will incorporate HPSB principles	Incorporate HPSB principles for Discovery Park and any new facilities	Incorporate HPSB principles for all new buildings and facilities including EIC
Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.	0	Continue to engage national laboratory community on techniques to meet these requirements Consider options for designating an existing building "Net-Zero" using the NSERC as the renewable energy source	Evaluate Net-Zero options for Discovery Park	Evaluate Net-Zero options for new facilities

Prior DOE Goal	***Current Performance Status***	***2 Year Performance & Plans***	***5 Year Performance & Plans***	***10 Year Performance & Plans***
Increase regional and local planning coordination and involvement.	Working with state and local utilities on a long-term plan to align BNL's growth with the regional development plans. This plan includes potential collaboration with the mixed-use development across from the Lab for temporary housing of staff and guests. BNL is also working closely with the MTA on the relocation of the Yaphank Train Station. This will allow staff to use mass transit for their commute	Working with state and local utilities on a long-term plan to align BNL's growth with the regional development plans. This plan includes potential collaboration with the mixed-use development across from the Lab for temporary housing of staff and guests. BNL is also working closely with the MTA on the relocation of the Yaphank Train Station. This will allow staff to use mass transit for their commute	Working with state and local utilities on a long-term plan to align BNL's growth with the regional development plans. This plan includes potential collaboration with the mixed-use development across from the Lab for temporary housing of staff and guests. BNL is also working closely with the MTA on the relocation of the Yaphank Train Station. This will allow staff to use mass transit for their commute	Working with state and local utilities on a long-term plan to align BNL's growth with the regional development plans. This plan includes potential collaboration with the mixed-use development across from the Lab for temporary housing of staff and guests. BNL is also working closely with the MTA on the relocation of the Yaphank Train Station. This will allow staff to use mass transit for their commute
Acquisition & Procurement				
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in all applicable contracts.	100%	Assess contracts to identify areas for improvement Improve performance by targeting specific chemicals/product s for replacement with bio-preferred product	Implement improvement plans identified by the assessment	Continue to seek products for replacement
Measures, Funding, & Training				
Annual targets for sustainability investment with appropriated funds and/or financed contracts to be implemented in FY 2019 and annually thereafter.	$1,613k	$2,330k	$3,000k Includes UESC II payment	$3,000k UESC I payments complete. Includes UESC II and possible USEC III payments

Prior DOE Goal	*Current Performance Status*	*2 Year Performance & Plans*	*5 Year Performance & Plans*	*10 Year Performance & Plans*
Electronic Stewardship				
Purchases: 95% of eligible acquisitions each year are EPEAT-registered products.	97.4%	Maintain current performance.	Maintain current performance.	Maintain current performance.
Power management: 100% of eligible PCs, laptops, and monitors have power management enabled.	32%	Maintain current program of enabling power management (PM) when distributing new computers and laptops to staff Maintain current exemption list of those who can't have PM features activated due to PC access needs Continue communication to staff regarding the benefit of leaving PM options enabled	Maintain program	Maintain program
Automatic duplexing: 100% of eligible computers and imaging equipment have automatic duplexing enabled.	76.8% (Duplexing)	Maintain current program of setting equipment to automatic duplexing when distributing to staff. Maintain Lab policy regarding duplex printing. Continue communication to staff regarding the benefit of leaving PM options enabled	Maintain program	Maintain program

Prior DOE Goal	***Current Performance Status***	***2 Year Performance & Plans***	***5 Year Performance & Plans***	***10 Year Performance & Plans***
End of Life: 100% of used electronics are reused or recycled using environmentally sound disposition options each year.	100%	Maintain current program/ performance	Maintain current program/ performance	Maintain current program/ performance
Data Center Efficiency: Establish a power usage effectiveness target for new and existing data centers; discuss efforts to meet targets.	The CFR Project will allow for the consolidation of data centers. The CFR was designed to meet current efficiency requirements in the Data Center Optimization Initiative	The CFR Project will allow for the consolidation of data centers. The CFR was designed to meet current efficiency requirements in the Data Center Optimization Initiative	The CFR Project will allow for the consolidation of data centers. The CFR was designed to meet current efficiency requirements in the Data Center Optimization Initiative	The CFR Project will allow for the consolidation of data centers. The CFR was designed to meet current efficiency requirements in the Data Center Optimization Initiative
Organizational Resilience				
Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.	The Modernization Project Office (MPO) has incorporated the New York State current standards for design resilience into all of its standard specifications The Office of Emergency Management (OEM) has established procedures for responding to all climate events and will update them as needed	The Modernization Project Office (MPO) has incorporated the New York State current standards for design resilience into all of its standard specifications The Office of Emergency Management (OEM) has established procedures for responding to all climate events and will update them as needed	The Modernization Project Office (MPO) has incorporated the New York State current standards for design resilience into all of its standard specifications The Office of Emergency Management (OEM) has established procedures for responding to all climate events and will update them as needed	The Modernization Project Office (MPO) has incorporated the New York State current standards for design resilience into all of its standard specifications The Office of Emergency Management (OEM) has established procedures for responding to all climate events and will update them as needed
Multiple Categories				
YOY scope 1 & 2 GHG emissions reduction from a FY 2008 baseline.	-41.9%	-43%	-48% goal Includes UESC II	-60% goal Includes UESC II, potentially UESC III, and RECs to

Prior DOE Goal	*Current Performance Status*	*2 Year Performance & Plans*	*5 Year Performance & Plans*	*10 Year Performance & Plans*
				meet goals. Anticipate load growth with EIC which will put considerable pressure on reducing GHG's
YOY scope 3 GHG emissions reduction from a FY 2008 baseline.	-12.8%	Continue to encourage ride-sharing for BNL guests and employees and usage of video and audio-conferencing services to reduce business travel for offsite meetings	Continue to encourage ride-sharing for BNL guests and employees and audio-conferencing services to reduce business travel for offsite meetings Expect reductions due to new planned rail station near BNL	Continue to encourage ride-sharing for BNL guests and employees and audio-conferencing services to reduce business travel for offsite meetings Expect losses associated with electrical T&D to go down due to new transmission systems needed to meet New York State's aggressive off-shore wind and other renewable energy projects

II. Mission Change

This category discusses mission changes and program direction over the next five to ten years. It includes potential impact on sustainability goals and provide projections. For major initiatives, it discusses the site strategic vision and how sustainability goals will be influenced.

BNL has identified seven scientific initiatives that, when achieved, will help realize the vision for the Lab. The major initiative areas for BNL are:

1) **Nuclear Physics: RHIC, EIC**—Exploit RHIC's unique capabilities to learn about the matter that makes up nearly all the visible universe and set the foundation to transition to an Electron-Ion Collider.

    - The potential BNL EIC complex would likely add additional buildings and increase energy use.

2) **Materials and Chemical Sciences**—Integrate BNL's expertise, ideas, and facilities to focus on select timely goals in Materials and Chemical Sciences.

    - The anticipated construction of additional beamlines will increase the utilization of the National Synchrotron Light Source (NSLS)-II, Building 740, and increase its energy consumption.

    - There are currently two building additions to NSLS laboratory office buildings (LOBs) under construction that have applied the Guiding Principles in their design to the extent possible based on the nature of the facilities.

3) **Making Sense of Data at Exabyte-scale and Beyond**—Create solutions for experiment-related computing to enable near-real-time data analysis and experimental steering.

    - New computing facilities are under construction in the existing Building 725. It is anticipated that the new computing facilities will have a PUE of 1.3 which is within DOE guidelines.

4) **High Energy Physics: Building for Discovery**—Steward the participation of U.S. high energy physicists in global particle physics experiments that explore the Standard Model and search for phenomena that signal physics beyond the Standard Model.

    - There are no foreseeable sustainability impacts anticipated by this research and its required facilities.

5) **Accelerator Science and Technology: From Innovations to Applications**—Build on the Lab's unique combination of accelerator-based facilities and broad technical expertise to support efforts in accelerator science and technology that range from innovations to applications.

    - Support for the potential EIC upgrade could have sustainability impacts on the research and its required facilities.

6) **Quantitative Plant Science Initiative**—Accelerate genome-to-function understanding to advance fundamental discoveries in plant science relevant to the DOE mission in energy security.

    - A current capitol project will eliminate once-through waters systems previously used for cold

boxes.

7) **Quantum Information Science and Technology Cross-cut**—Leverage BNL's expertise in materials, instrumentation and networking, codes and algorithms to develop infrastructure that will enable scalable, large, and effective quantum systems in partnership with leading quantum experts.

    - There are no foreseeable sustainability impacts anticipated by this research and its required facilities.

BNL's scientific vision is structured around the achievement of these science initiatives, while additional operational initiatives enable and ensure the delivery of the research mission.

1) **Renewed Research Campus**—The Lab's strategy for mission readiness will provide a revitalized physical plant to improve scientific productivity, promote the attraction and retention of the scientific workforce, including the significant BNL user population, and assure the safe, reliable functioning of BNL's major scientific facilities.

    - Projects such as the Science and User Support Center (SUSC), enabling further consolidation into more energy efficient facilities, and UESC-II will reduce energy usage.

    - The redesign of current the Well 11 and the future new Well 12 will be water saving in that less water will be lost going through the water treatment plant

II. Performance Review and Plan Narrative

Energy Management

This category focuses on all energy-related topics such as energy intensity, metering and benchmarking, Energy Independence & Security Act (EISA) §432 evaluations, non-fleet fuel use, and greenhouse gas (GHG) emissions.

Performance Status

Energy Intensity

BNL's energy intensity for FY19 was 236,426 Btu/gsf and was 27.2% lower than the base year of 2003. This lower intensity level saved BNL nearly $2.5 million in FY19 alone. The reduction goal of 30% by 2015, and 1% each year after (34% by 2019) has been difficult to meet. Moreover, Energy intensity is greatly affected by many factors, including several beyond our ability to control, the most significant of which is weather. BNL is located in the Northeast and fuel for heating is the most dominate energy source for buildings. Other factors affecting energy intensity include changing outdoor air code requirements, increased density/occupancy of new facilities, and constantly changing technologies including computers and related IT systems, lighting, and others.

Figure 1 (below) depicts the energy use intensity (EUI) for non-excluded buildings (i.e., goal subject ones) at BNL greater than 5,000 gsf with an EUI of 150 kBTU/GSF or above:

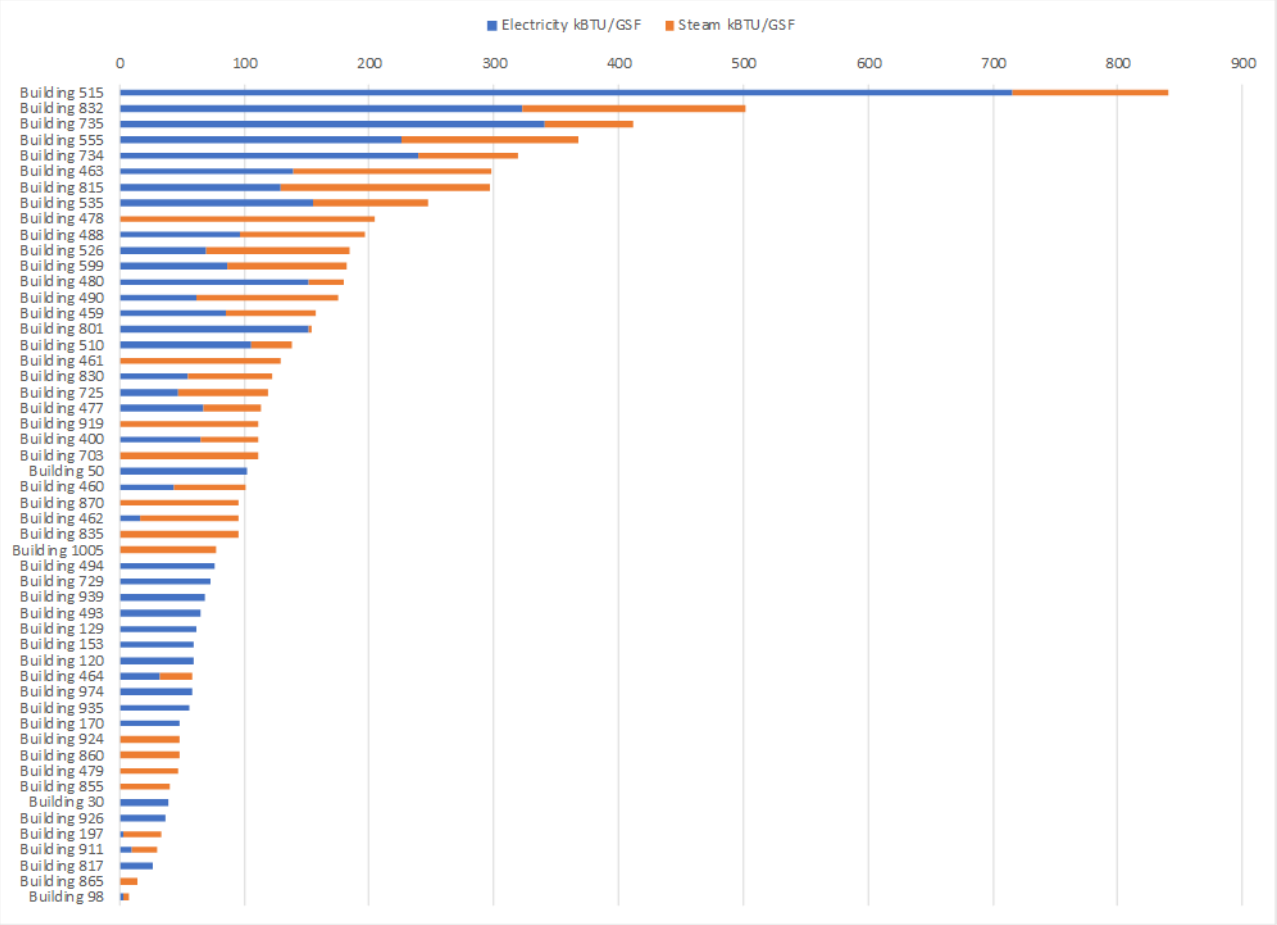


Figure 1: EUI for Non-Excluded Buildings

FY19 was the fourth full year with the results of the Utility Energy Service Contract (UESC) Phase I project. The energy savings were once again verified to be within a few percent of the original estimates. The UESC has contributed to lowering BNL's overall energy intensity value.

Temperature Setback Policy is regularly communicated to the Laboratory via several methods, including Earth Day events and presentations to facility managers and Laboratory management.

BNL has a long history of aggressive energy conservation measures dating back to the early 1970's. Over $62 million has been invested including the recently completed (2015) $12 million UESC. A second UESC effort is being considered to reduce energy use based on an Investment Grade Audit (IGA) that was completed in September 2019.

The biggest factor affecting BNL's ability to continue to reduce energy intensity is the lower electricity rates and current low fuel prices. While the low rates/prices are excellent for continuing research programs, they make it extremely difficult to find cost-effect projects, especially when paired with high construction costs. Further, most of the most attractive projects have already been completed. Regardless, BNL will continue to strive to reduce energy intensity.

BNL continues to maintain a long-standing, well developed energy conservation program that utilizes a number of the tools and Best Management Practices (BMP) including:

- Utilizing the latest Building Automation System (BAS) software to identify inefficiencies (remote auditing);
- Participating in Demand Management programs;
- Entering performance data in Environmental Protection Agency (EPA) Energy Star Portfolio Manager;
- Utilizing the latest BAS software to communicate building energy usage (effectively "Green Button");
- Space management and optimization practices;
- Comprehensive Data Center metering and monitoring; and
- Targeting Data Center power utilization effectiveness (PUE) of less than 1.5 for existing facilities and 1.2 to 1.4 for new facilities.

Deferred Maintenance Reduction

BNL's recently completed UESC project specifically targeted buildings that had systems in need of maintenance and replacement of obsolete controls and lighting. Not only was future deferred maintenance reduced by approximately $8.9 million but energy efficiency was also improved. As previously discussed BNL is in the process of developing a potential second UESC project, also targeting deferred maintenance.

Life-Cycle Cost Analysis

Most of BNL's major initiatives and all energy related projects have Life-Cycle Cost (LCC) Analyses performed to ensure that they are economically viable. The level of rigor is based on numerous factors including the complexity, scope, environmental impact, and cost of the project/initiative. DOE's Building Life-Cycle Cost (BLCC) programs, among several others are used for the evaluations.

Fossil Fuel Reduction (EISA Section 433) in New Buildings

BNL strives to reduce fossil fuel use in new buildings by having them designed and constructed to the most efficient, cost effective levels possible. By meeting the High-Performance and Sustainable Buildings (HPSB) criteria, energy use is minimized. Further, alternatives to fossil energy sources are thoroughly evaluated (i.e. renewable energy, daylighting, ground source heat pumps, etc.) during the design.

Energy and Facility Manager Training

There are a few Certified Energy Managers (CEM) at BNL including the Manager of Energy Management and the Data Center Manager. All of the facility complex managers (FCMs) throughout the BNL campus have the Certified Facility Manager (CFM) recognition from the International Facilities Management Association (IFMA). All of the FCMs and Facility Complex Engineers (FCEs) participate in various training programs throughout the year to ensure core competencies.

New Construction Design for 30% Improvement over ASHRAE 90.1 2010

All new construction designs at BNL are required to design for a 30% improvement in energy efficiency, as compared to ANSI/ASHRAE/IESNA Standard 90.1, whenever cost effective. The planned new Science and User Support Center (SUSC) is currently being designed to this criteria.

DOE Better Buildings Program / ISO 50001 Ready Program

BNL is still in the preliminary stages of evaluating the DOE Better Buildings Program. Due to limited resources minimal progress has been made in this area. Discussions regarding ISO 50001 have taken place.

EISA Section 432 Evaluations and Benchmarking

Energy audits of HVAC systems, lighting, and office equipment continue to be used to identify opportunities for energy conservation. The findings help to develop policies on operation and equipment needs. These audits are being performed in conjunction with ongoing Facility Condition Assessment (FCA) surveys in order to reduce additional costs and administrative oversight needs. All information has been placed in EPA's Portfolio Manager Program for benchmarking.

Information from the energy and water audits was taken into consideration with the recently completed Investment Grade Audit (IGA) for another potential UESC effort.

Measurement and Verification (M&V)

Measurement and Verification (M&V) is an important process to ensure performance of energy and water conservation projects. BNL's existing comprehensive metering system is and has been a tremendous resource for our M&V efforts. For the UESC Phase I project a Performance Assurance Plan (PAP) was used to verify project performance after initial completion and has continued to be used. BNL required the UESC contractor (ESCo) to complete the first year M&V effort. For the remaining years BNL assumed the responsibility of reporting on the project performance. This approach has worked extremely well and is being used as a model for other M&V related efforts going forward including the UESC II effort currently underway.

Facility Metering

BNL continued its long tradition of advanced metering efforts in FY19 and is meeting the metering goals for electricity, natural gas, and chilled water. During FY19 five (5) additional advanced electric meters were installed and two (2) advanced steam meters were installed.

There are nearly 300 advanced electric meters are currently installed and they capture over 98% of consumed electricity. Of the 159 buildings greater than 4,000 square feet, 153 (96%) advanced meters are installed.

Chilled water is metered at 100% with 34 advanced chilled water meters installed in 34 buildings or loads with chilled water, and all three (3) of BNL's natural gas-supplied facilities have advanced meters installed.

Approximately 90% of the steam consumption is metered with advanced steam/condensate metering in 45 of the largest buildings. However, 23 buildings still have conventional steam meters that will be upgraded as appropriate.

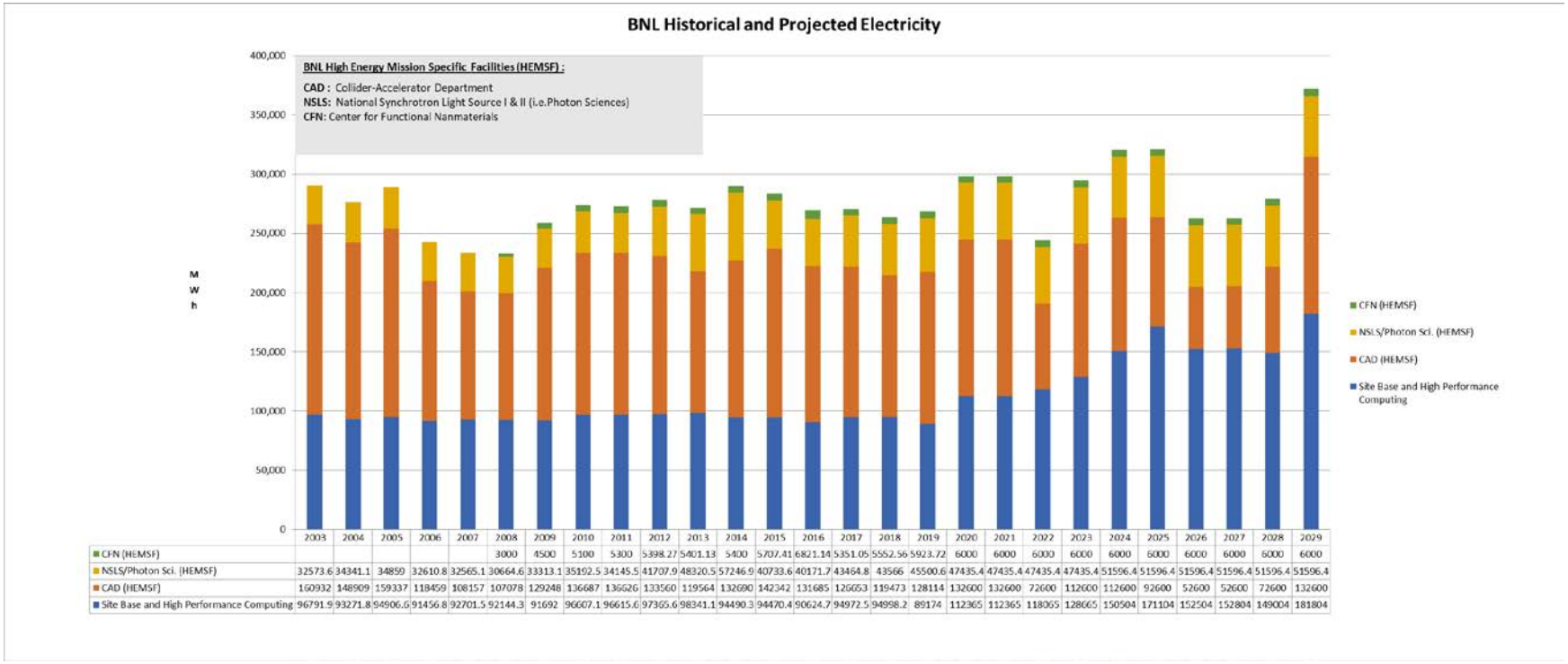
Due to BNL's low cost of water (less than $0.45 per 1,000 gallons), the installation of water meters is not economically justifiable. However, BNL's major facilities with cooling towers, as well as new buildings and major renovations include water metering. A substantial amount of the water used at BNL is utilized by cooling towers, most of which are currently metered. BNL installed one new cooling tower meter in 2019 and plans to meter all cooling towers within the next few years.

As previously stated BNL has a long history of advanced metering dating back over 36 years. Energy data is utilized for the following purposes:

- Verification of utility bills.
- Internal utility cost re-distribution of all energy streams (electric, chilled water, steam) to various departments and organizations.
- M&V for both third party and internal energy and water conservation projects.
- Participation in electric load curtailment programs that allows BNL to reward individual departments and organizations in direct relation to their contribution to the curtailment.
- Live monitoring of energy usage.
- Troubleshooting and evaluation of unusual loads.
- Sizing of energy distribution systems.
- Energy use optimization when combined with the site-wide energy management control system.

Electric Usage Projections

The following chart summarizes BNL's historical and projected electricity usage for High-Energy Mission-Specific Facility (HEMSF) and the Site Base.



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
CFN (HEMSF)						3000	4500	5100	5300	5398.27	5401.13	5400	5707.41	6821.14	5351.05	5552.56	5923.72	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
NSLS/Photon Sci. (HEMSF)	32573.6	34341.1	34859	32610.8	32565.1	30664.6	33313.1	35192.5	34145.5	41707.9	48320.5	57246.9	40733.6	40171.7	43464.8	43566	45500.6	47435.4	47435.4	47435.4	47435.4	51596.4	51596.4	51596.4	51596.4	51596.4	51596.4
CAD (HEMSF)	160932	148909	159337	118459	108157	107078	129248	136687	136626	133560	119564	132690	142342	131685	126053	119473	128114	132600	132600	72600	112600	112600	92600	52600	52600	72600	132600
Site Base and High Performance Computing	96791.9	93271.8	94906.6	91456.8	92701.5	92144.3	91692	96607.1	96615.6	97365.6	98341.1	94490.3	94470.4	90624.7	94972.5	94958.2	89174	112365	112365	118065	128665	150504	171104	152504	152804	149004	181804

Figure 2: BNL Historical and Projected Electricity

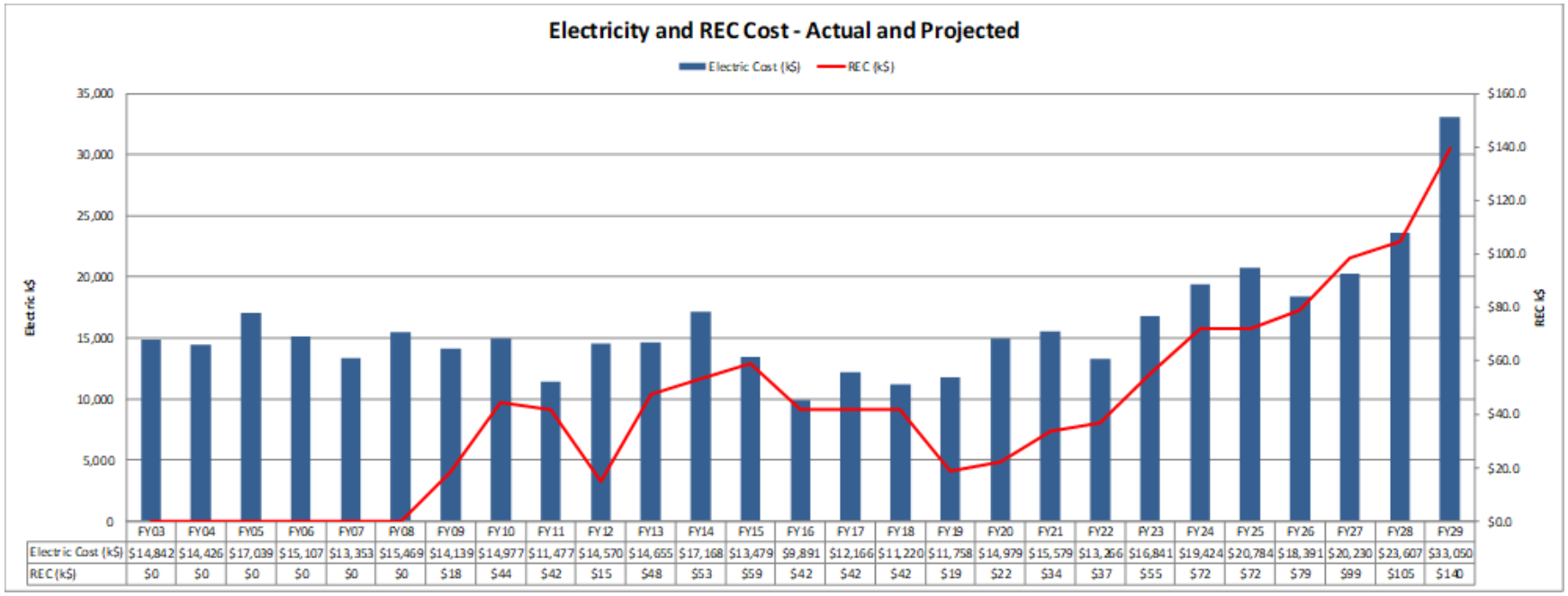
The data center, or High-Performance Computing (HPC) facility, is included with the "Site Base". BNL is currently constructing a new data center as part of the Computational Science Initiative (CSI) that will add nearly 8 megawatts (MW) of electrical load beginning in 2021. Initially the new data center load will be approximately 3 MW but will increase over a few years to the full build-out of 8 MW.

The electricity consumption estimates include reductions in certain years as the Collider-Accelerator Department (C-AD) prepares for the Electron-Ion Collider (EIC) project. The EIC is not expected to begin operation until 2029 or later.

Electricity and REC Cost Projections

The chart below shows electricity and Renewable Energy Credit (REC) cost history and projections. BNL's REC purchases to-date have been relatively inexpensive, under $1/MWh for the last few years. However, given the increasing renewable and clean energy requirements from New York State's new Climate Leadership and Community Projection Act (CLCPA), BNL anticipates substantial increases in REC and energy pricing as the years progress. The CLCPA requires 100% of all electricity generation to be renewable by 2040.

The table assumes that rates will increase to ~$2/MWh by 2022 and to ~$5/MWh by 2027. These assumptions are based on discussions with a few REC providers and will be updated in future Site Sustainability Plans (SSPs).



	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
Electric Cost (k$)	$14,842	$14,426	$17,039	$15,107	$13,353	$15,469	$14,139	$14,977	$11,477	$14,570	$14,655	$17,168	$13,479	$9,891	$12,166	$11,220	$11,758	$14,979	$15,579	$13,266	$16,841	$19,424	$20,784	$18,391	$20,230	$23,607	$33,050
REC (k$)	$0	$0	$0	$0	$0	$0	$18	$44	$42	$15	$48	$53	$59	$42	$42	$42	$19	$22	$34	$37	$55	$72	$72	$79	$99	$105	$140

Figure 3: Electricity and REC Cost – Actual and Projected

Energy cost projections, particularly for electricity, will require constant vigilance in light of New York State's recently passed law the "Climate Protection and Community Investment Act" (CLCPA). This law directs existing state agencies such as the Public Service Commission (PSC), the New York State Energy Research and Development Authority (NYSERDA), the New York Department of Environmental Conservation (NYDEC) as well as others yet to be developed, to address the following goals:

- Reduce statewide greenhouse gas emissions zero (0) percent below 1990 levels by 2050.
- Offset the remaining 15 percent of greenhouse gas emissions.
- Maximize benefits for disadvantaged communities, including requiring that they receive 40% of overall benefits of spending on clean energy efficiency programs, projects or investments.

In the electricity sector the Act requires:

- 70 percent of the electric generation secured by load-serving entities regulated by the Public Service Commission to be produced by renewable energy systems by 2030.
- Statewide electrical demand system to be net-zero carbon emissions by 2040.
- The procurement of at least:
    - Nine gigawatts (GW) of offshore wind electric generation by 2035.
    - Six GW of distributed photovoltaic solar generation by 2025.
    - Three GW of statewide energy storage capacity by 2030.
- 185 trillion BTUs of end-use energy savings below the 2025 energy use forecast.

The CLCPA will require fundamental changes to New York's energy sectors at what can only now be assumed to be potentially massive costs. To-date no cost estimates or analyses have been completed. Given the long-lead time we will anticipate relatively modest electricity cost increases in the near-term.

Plans and Projected Performance

Energy Intensity

Further reductions in Energy Intensity continues to be the biggest energy related challenge for BNL. Since the late 1970's, BNL has implemented numerous energy conservation projects, meeting two of the three previous energy intensity reduction goals of 30% (1985 vs. 1973), 30% (2003 vs. 1985), and 30% (2015 vs. 2003). BNL is currently at a 27% reduction vs. 2003.

As a result of these past efforts, BNL has reduced its energy intensity by approximately 440,000 Btu/sq. ft. (66%). Unfortunately, the previous reductions naturally targeted the most financially attractive projects which now make it very difficult to identify new cost-effective projects.

As previously stated, BNL has begun a UESC Phase II effort. If cost-effective projects can be identified for Phase II, BNL will be able to reduce energy intensity. All energy-related projects will be analyzed using Life-Cycle Analyses.

Heating, Ventilation, and Air Conditioning (HVAC) Setback

A setback capability for HVAC systems continues to be implemented throughout the BNL campus. The FCMs and their staff regularly evaluate systems to ensure that this function is operating as intended. Setback will be captured by using the new Building Automation Program. FCMs will communicate with building occupants about energy usage and the benefits of HVAC setback and energy conservation. Any future lease agreements will be modified to incorporate setback clauses. Further, the existing preventative maintenance (PM) program was recently enhanced for all HVAC systems. The HVAC setback initiative will continue to be emphasized in FY18 as part of BNL's educational effort for the facility managers. This is part of a larger site-wide effort to encourage active employee participation in various conservation efforts.

Steam Charge-back

A steam cost charge-back program was developed for implementation in the near future to encourage energy conservation. BNL has long used direct charges to building occupants and departments for electricity and chilled water, which is one of the most effective methods to increase energy conservation. There was concern from at least one department regarding a major financial impact that would result from direct billing of steam/fuel. One option under consideration is to have the steam charges be phased into a 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 energy savings of approximately 62,000 mmBtu/year. BNL will continue to work towards steam charge-back in the near future.

Lighting Upgrades

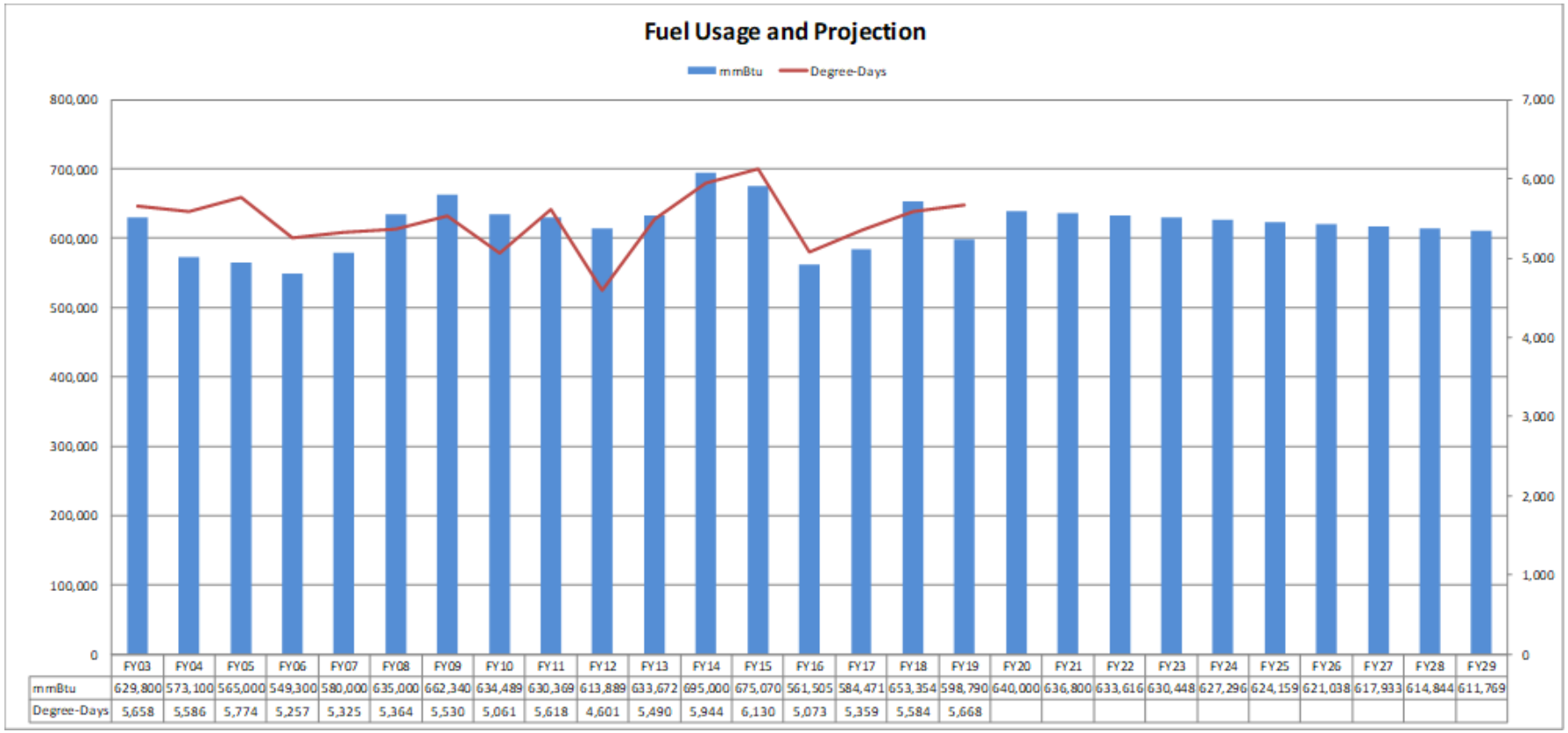
Planning will continue for BNL's ongoing program of upgrading lighting throughout the Laboratory with high efficiency replacements. Automated controls will be installed where appropriate.

Metering

Additional meters will be installed as opportunities become available. Electric and steam meter installations often require extensive coordination and shutdown of operations. BNL strives to install at least five (5) electric meters and three (3) steam/condensate meters annually but a number of factors affect our ability to complete the work. The biggest issue is limited funds and coordination of building operations if shutdowns are required. In FY19 the Lab was able to meet the goal of installing the goal of (5) advanced electric meters.

Fuel

Over 95% of the fuel use at BNL is for the Central Steam Facility. Estimated fuel use going forward is expected to be flat to slightly declining, mainly due to continued efficiency improvement projects and a reduction of older underutilized facilities.



	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
mmBtu	629,800	573,100	565,000	549,300	580,000	635,000	662,340	634,489	630,369	613,889	633,672	695,000	675,070	561,505	584,471	653,354	598,790	640,000	636,800	633,616	630,448	627,296	624,159	621,038	617,933	614,844	611,769
Degree-Days	5,658	5,586	5,774	5,257	5,325	5,364	5,530	5,061	5,618	4,601	5,490	5,944	6,130	5,073	5,359	5,584	5,668										

Figure 4: Fuel Usage – Actual and Projected

Water Management

This category focuses on activities undertaken to reduce potable and non-potable water consumption, comply with stormwater management requirements, and improve water efficiency.

Performance Status

BNL obtains its potable, process cooling, and fire protection water from Long Island's underground aquifer. BNL runs its own NYS-regulated "community water system" which consists of five (5) water wells, a Water Treatment (Iron Removal / Filter) Plant, two (2) elevated water storage tanks with a capacity of 1.3 million gallons, and an underground distribution system with about 45 miles of piping, valves, and hydrants.

BNL has a long history of reducing water consumption – even though water on Long Island is plentiful and inexpensive. BNL has conducted an effective water-reduction and conservation program for more than 20 years, illustrated in Figure 5 by the trend in annual potable (includes process) water usage.

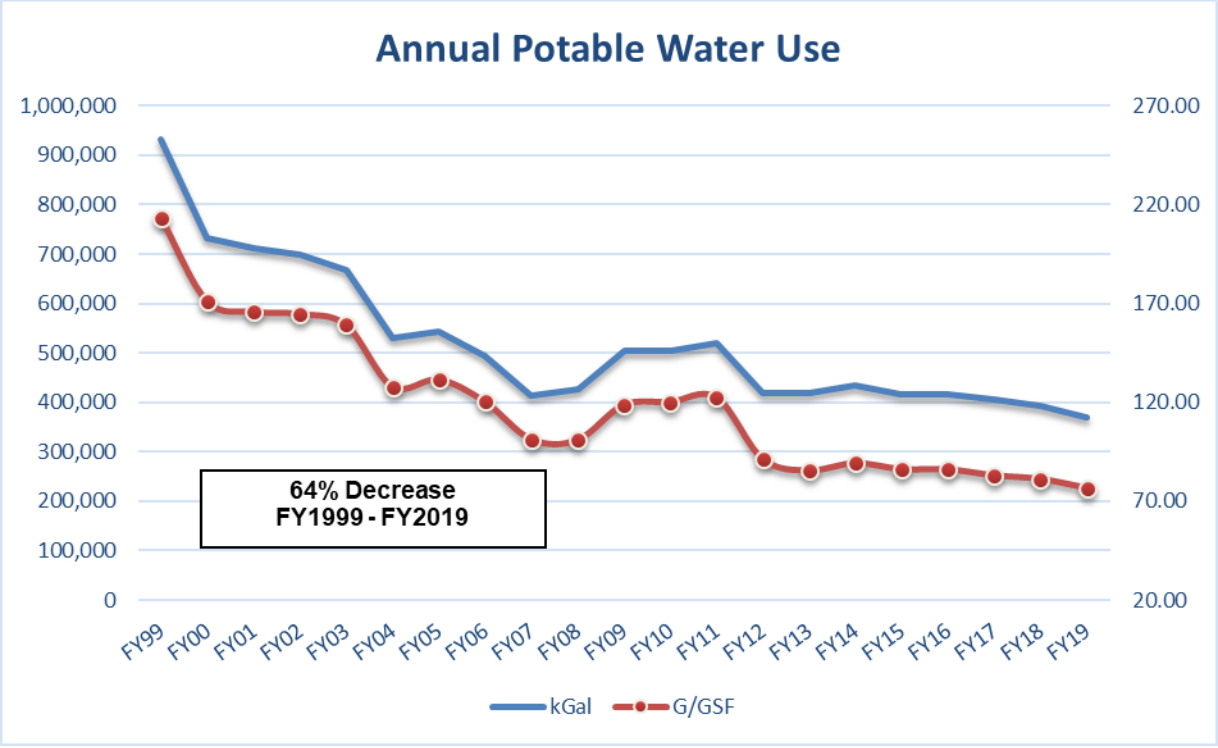


Figure 5: Annual Potable Water Use (1999-2019)

Potable-water usage fell from 931 million gallons/year in FY 1999 (average of 2.55 million gallons per day) to about 368 million gallons/year in FY 2019 (average of 1 million gallons per day), a reduction of 64.0%. 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 76.5 gallons per square foot, a 24.4% water usage reduction since base-year 2007. The table below illustrates the change in site gross square footage.

Table 1: Annual Change Gal/GSF Water Use (1999-2019)

FY	kGal	GSF	G/GSF
FY99	931,452	4,363,224	213.48
FY00	732,408	4,281,455	171.07
FY01	710,583	4,286,993	165.75
FY02	698,340	4,241,450	164.65
FY03	666,916	4,191,562	159.11
FY04	530,414	4,148,593	127.85
FY05	542,568	4,128,355	131.42
FY06	493,641	4,105,635	120.23
FY07	412,935	4,081,900	101.16
FY08	427,400	4,237,100	100.87
FY09	504,500	4,252,200	118.64
FY10	505,075	4,203,457	120.16
FY11	520,308	4,249,150	122.45
FY12	418,153	4,586,455	91.17
FY13	419,372	4,906,797	85.47
FY14	433,718	4,865,753	89.14
FY15	416,904	4,843,649	86.07
FY16	417,364	4,854,679	85.97
FY17	406,876	4,905,386	82.94
FY18	393,096	4,845,380	81.13
FY19	368,520	4,815,914	76.52

Site gross square footage has changed with the addition of scientific processes. BNL continues to see a decrease in gallons of potable water even as site growth occurs. This is largely due to water conservation efforts and an increase in efficient process water cooling technologies.

Figure 6 depicts how BNL uses its potable water, and where it goes thereafter. Note that 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 is also used to make up for evaporative, drift and blowdown losses from re-circulating cooling towers. Tower blow-down is typically discharged into sanitary or storm sewers, treated, and ultimately, returns to the groundwater.

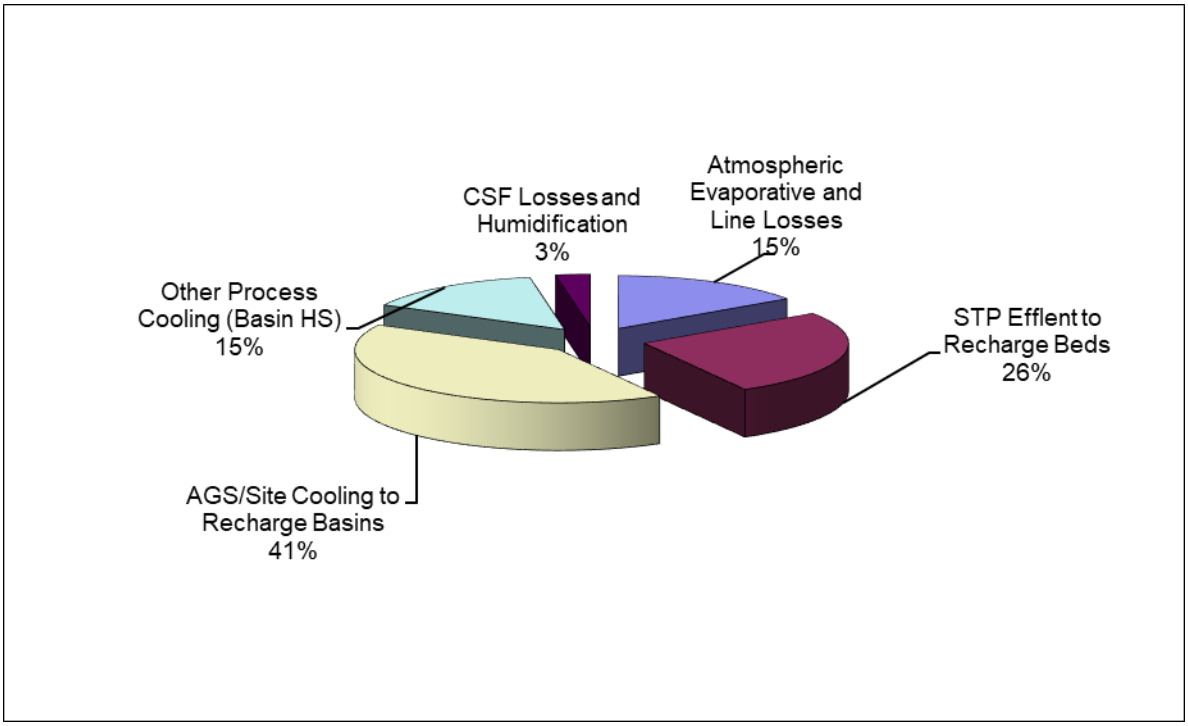


Figure 6: 2019 Potable Water Utilization

In October 2014, BNL implemented groundwater recharge of treated wastewater at its Sewage Treatment Plant. Currently, about 82% of water used at BNL is recharged (recycled) to groundwater via groundwater recharge basins. The water recharged is near potable water quality.

We estimate that over two-thirds of BNL's water production is attributable to High Energy Missions Specific Facilities.

Plans and Projected Performance

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 continue to reduce water usage by implementing best-management practices. The E.O. 13834 goals require that BNL reduce potable water intensity (Gal per gross square foot) by 20% relative to FY07 by FY15 and 0.6% year after year thereafter.

Presently, we are implementing best-management practices (BMPs) as detailed in Section 2.2 of our 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 $0.50 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 equipment's 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 (aligned with other priorities).

The redesign of Well House No. 11 on site will reduce the need to use older wells therefore reducing the Water Treatment Plant filter back-wash cycles by restoring the carbon filtration system. This has anticipated water usage reduction of 3% to 5% overall.

Finally, we emphasize that over 80% of BNL's water consumption is returned and recharged to groundwater at potable water quality. We believe that BNL's groundwater recharge fully meets the DOE's water management "recycling" or "non-consumptive" criteria (except for insignificant temperature changes). To increase the rate of on-site recharge, BNL completed a project in 2014 to re-route the treated effluent from the sewage treatment plant from a surface water discharge to a groundwater recharge system. This project eliminates a potential source of trace metals contamination to the Peconic River and improves 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 resulted in an increase of over 100 million gallons per year recharged locally versus off-site flow via the Peconic River.

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, WaterSense 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 55% water use intensity reduction.

- Cooling-tower Systems. To reduce water use in once-through cooling systems, BNL has 22 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 80% 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 Executive Order 13834 "Efficient Federal Operations".
- Sewage Treatment Plant Effluent Recharge. A modification to convert BNL Sewage Treatment Plant from surface water discharge (Peconic River) to groundwater recharge / recycling was completed in September 2014. Purified wastewater (effluent) from BNL operations is currently being recharged and recycled to groundwater.

All new construction and renovation at BNL will continue to utilize water-efficient processes and plumbing fixtures to conserve water.

In FY16, the Laboratory funded engineering and design of a new Well House No. 12. Start of construction of the new well house is now planned for FY20. Total estimated cost (TEC) for the project will be about $1,000K. The new well house will replace the well house structure destroyed in a propane explosion in October 2008. Well No. 12 is located in an area of the BNL site with low-iron groundwater. Return of Well No. 12 to operation will reduce the need operate BNL's high-iron wells – Well Nos. 4, 6, and 7. This in turn will reduce the duty on BNL 's Water Treatment (i.e., Iron Removal / Filter) Plant, and reduce the number of backwash cycles and backwash wastewater. This could reduce BNL's water usage by 3% to 5%.

We continue to expect that increased, "main-mission" science program activities, with their need for accelerator cooling will tend to increase water consumption, due to cooling tower evaporation. This is not as significant an issue at BNL as it is at DOE facilities located in arid locales. Groundwater recharge from annual precipitation (almost all storm water is recharged on site) is orders of magnitude greater BNL's water usage that is "lost" due to evaporation (in evaporative cooling towers).

Waste Management

This category focuses on the site's approach/vision for addressing waste management, pollution prevention (source reduction) and recycling measures, and construction and demolition (C&D) waste reduction.

Performance Status

BNL has a mature established waste reduction and diversion program that recycles the following components:

- Mixed paper
- Cardboard
- Bottles and cans
- Tires
- Construction & demolition debris (C&D)
- Used motor oil
- Metals
- Concrete/asphalt,
- Lead acid (automotive/UPS) batteries
- Garnet
- Fluorescent bulbs
- Blasocut (cutting oil coolant)
- Scrap electronics
- Animal bedding (composted)

As evidenced by the graph below, BNL's annual diversion rate on non-hazardous solid waste has been above the department's 50% goal for the past 19 years. During FY18, the recycling rate considering waste generated from normal daily activities was approximately 68%.

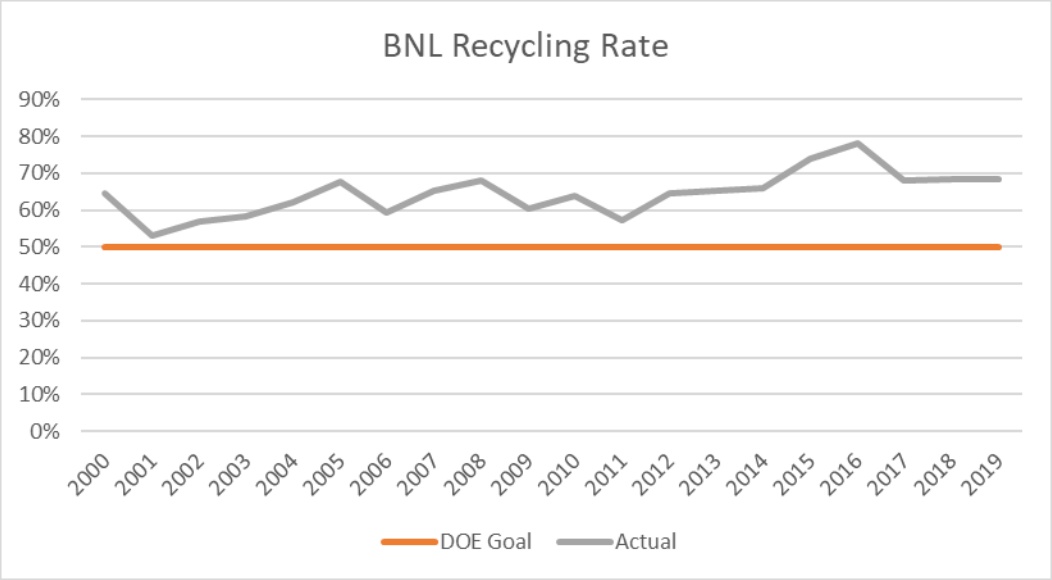


Figure 7: BNL's Recycling Rate

This number does not account for major one-time projects that generate large amounts of debris, such as building demolition or land clearing for construction. Taking the building demolition into account that occurred during FY19 (Building 134 and the 528 and 902 modulars) as well as the removal of trees

associated with the construction of a traffic circle, the recycling rate jumps to 80% as much of the C&D debris is sent to a recycler and the trees are composted on-site.

Building 134 Demolition

In the past, the Lab's putrescible waste (municipal solid waste) had been sent to a waste-to-energy facility, but the contract was changed to a contracted vendor who collects it and then hauls it to an offsite to a landfill. Although large amounts of C&D debris from demolition projects are recycled, smaller amounts of C&D type waste generated from daily activities are landfilled. The typical volume of these waste streams together account for an average of 828 tons of waste generated annually.

Earth Day Recycling Program Promotion

The Lab activity promotes its recycling program through use of special containers, labels, flyers, and websites. Staff Services repeated its recycling program promotion event during the Lab's Earth Day Celebrations that showcased the bio-preferred products they use for custodial services. They also promoted good recycling habits by engaging staff in interactive question and answer activities. Staff Services also shared their environmentally-friendly cleaning practices with other DOE entities during a DOE Sustainable Acquisition Working Group teleconference. Staff Services also repainted and resigned recycling dumpsters the serve the on-site apartments to encourage better compliance in those areas.

Plans and Projected Performance

BNL's waste diversion program is expected to remain intact in the future years.

BNL will re-evaluate landfilled wastes during 2020 to see if there is opportunity to divert this waste stream back to a waste-to-energy facility.

Plans are in place to continue demolition of World War II structures. Apartment number 367 will be demolished during FY20. Resulting concrete from the demolition will be crushed on site to covert to Recycled Concrete Aggregate (RCA) for use as a road base on firebreak roads or as underlay in parking areas, saving dollars that would otherwise be used to purchase this type of material. Wood and metal debris will also be segregated and sent for recycling.

Fleet Management

This category focuses on the site's approach and vision for addressing fleet optimization, and strategies used to reduce petroleum use and increase alternative fuel use.

Performance Status

FY19 was the first full year that BNL utilized Telematics to track fleet operations. The fleet management software helps monitor fleet utilization and vehicle idling. In a broader sense, the Lab was able to see how the vehicles travelled in much more detail and obtained more information on the vehicles themselves.

BNL replaced some of the older fleet vehicles with newer, more fuel efficient and alternative fueled vehicles. Figure 8 below provides a snapshot of the vehicles leased by BNL, broken down by their fuel type. The newer vehicles should continue to help achieve goals surrounding the reduction of greenhouse gas emissions.

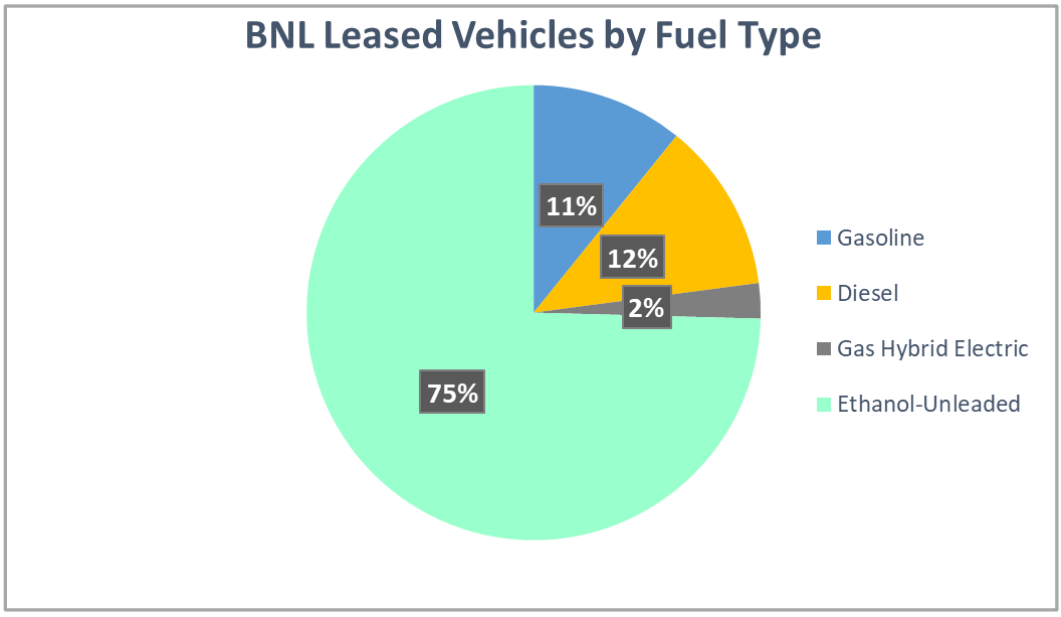


Figure 8: BNL Leased Vehicles by Fuel Type

Plans and Projected Performance

Fleet management will continue to work with the General Services Administration (GSA) to order and utilize alternative-fueled and newer, more fuel-efficient vehicles during every replacement cycle.

BNL has funded a project in FY20 to install the infrastructure needed to support charging stations for three (3) to four (4) electric vehicles. This infrastructure will enable future roll-outs of electric vehicles, planned to be order in the fall of 2020.

Renewable Energy

This category focuses on site efforts towards utilizing renewable energy resources.

Performance Status

BNL purchased 20,000,000 kilowatt hours (kWh) of RECs for 2019 to meet the "Renewable Energy" requirement of 7.5%. BNL's RECs have been and will continue to be purchased through a competitive solicitation process. Each solicitation includes the latest DOE requirements, including the required in-service dates.

In 2019 BNL's 816 kW Northeast Solar Energy Research Center (NSERC) facility produced 1,018,429 kWh that were consumed by BNL's facilities. The RECs are retained by BNL and are not sold.

BNL continues to host the Long Island Solar Farm (LISF), a 32 MW Solar PV generation system that provides power to the Long Island Power Authority (LIPA). Even though BNL does not receive any of the power generated from the LISF, it provides clean, renewable energy to the local area and region. The LISF produced 50,631,000 kWh in FY19.

BNL hosts the Long Island Solar Farm

BNL regularly evaluates alternative energy opportunities. The most recent effort was an updated economic evaluation of combined heat and power (CHP) in 2016. The report highlighted the potential to reduce GHGs by approximately 50,000 $MtCO_2e$ per year and act as an on-site source of "clean energy." There are a number of other benefits associated with CHP including providing increased resilience in the

event of impacts from weather or other events that could affect the electric grid. However, current and estimated low energy costs in the future continue to prevent CHP from being economically viable at this time.

Plans and Projected Performance

BNL will continue to operate the NSERC facility and provide for further expansion when sufficient funds are identified. Renewable energy credit (REC) purchases will continue in order to meet applicable renewable energy and clean energy goals.

The most recent renewable energy assessment that included the BNL site was completed by National Renewable Energy Laboratory (NREL) in 2016. The report concluded that even though the site is over 5,000 acres, given the existence of the 31-MW Long Island Solar Farm (LISF) on the BNL site and that much of the land is forested and in environmentally sensitive areas, BNL is concerned about clearing additional land for another renewable energy (RE) project.

The NREL report also states: "PV, biomass, LFG, and SHW do not appear economically viable at this time. Should the cost of electricity increase or escalate at a rate higher than what is assumed in the model or should the price of RE decreases or new incentives become available, then it is possible additional RE projects could become cost-effective." NREL did suggest consideration of small wind turbines given the Federal Aviation Administration's (FAA's) determination that large (300 ft. high) ones would pose an aviation problem in the area.

As indicated above in the current status section BNL completed an updated economic evaluation of a CHP in 2016 which concluded that BNL's low energy rates keep a CHP from being economically viable. The Lab will continue to revisit the CHP concept when the economic or other conditions change that could make it a viable undertaking.

Renewable energy systems, especially solar hot water, are considered in all new construction and major building renovations. To date, it has been difficult to find cost effective projects. However, a new office building, the Science and User Support Center, (SUSC) will be designed in 2020 and will potentially incorporate a number of concepts including solar hot water heating and potentially a solar wall for pre-heating.

BNL continues to pursue opportunities to implement a true microgrid on site. The ~1 MW NSERC facility is intended as one of the first segments that will ultimately be combined with energy storage. BNL is continuing discussions with energy storage providers and various governmental agencies to explore options such as hosting large utility scale battery storage systems on site.

Sustainable Buildings

This category focuses on all aspects pertaining to sustainable building initiatives such as HPSB as well as building inventory changes.

Performance Status

Guiding Principle (GP) Compliant List

Table 2: Guiding Principle Compliant Buildings and GSF

Property ID	Size s.f.	Compliant Year
0740	408,311	2017
0735	95,929	2014
0734	89,733	2014
0400	64,815	2015
0743	47,825	2017
0745	42,966	2018
0744	42,445	2018
0741	42,370	2017
0742	42,365	2017

Barriers and Most Difficult -GP's

The most significant barriers to meeting the Guiding Principles are the costs associated with meeting the Energy Efficiency, Water Use, and Commissioning. Of these three, meeting the Energy Efficiency requirements is by far the most expensive. BNL's relatively low energy rates and high construction costs make is extremely difficult to find cost-effective projects

Guiding Principles

Currently 11% of non-excluded buildings have achieved 100% of the Guiding Principles and an additional 9% are at 90% or higher. Of the excluded buildings 3% are at 90% or higher. As BNL constructs new buildings and demolishes old non-compliant buildings, this percentage will increase.

New Building Design

All buildings designed from 2007 were designed to meet the NYS Energy Code. In addition, BNL incorporates these principles into major renovations. These buildings meet or exceed the Guiding Principles and some of which also obtained Leadership in Energy & Environmental Design (LEED) certification. BNL's Design Standards (Modernization Project Office [MPO] Procedure 100E) for new buildings includes requirements to ensure that all new construction is at least 30% more efficient than ASHRAE 90.1-2013. Current EISA Section 433 is not applicable, as BNL does not have any planned commercial or multi-family high-rise residential buildings.

The new buildings designed during FY18 were the Building 742 HEX Beamline Satellite Building and Building 748 (Laboratory for Bio-Molecular Science), construction is expected to complete in FY20. To the extent that is practical and applicable, these new buildings will meet the GP's. While not a new building, Building 725 is undergoing a major renovation and those areas were designed to meet the Guiding Principles. The project Beneficial Occupancy Readiness Evaluation (BORE) is scheduled for 2021.

Net Zero Buildings

BNL has been discussing the option of applying the output of the NSERC to make one or more of the buildings net-zero. A final selection is anticipated in early FY20.

Leases

BNL does not have any building leases.

Regional and Local Planning, Coordination, and Involvement

Discovery Park

The Discovery Park Initiative includes discussion with the Metropolitan Transportation Administration (MTA) and Long Island Rail Road (LIRR) officials about relocation of the Yaphank rail station to a site closer to BNL to enable a new "Brookhaven National Laboratory" station. A study has been completed and $20M approved in the MTA budget to construct this new station, initially with service from diesel trains followed by eventual electrification and creation of a major commuter hub providing convenient public transportation options for BNL staff and visitors.

Plans and Projected Performance

Guiding Principles

Although overall site funding will drive the exact schedule, as new buildings are constructed to be fully compliant with the Guiding Principles and old non-compliant buildings are demolished, the percentage of buildings that are compliant with the GPs will further increase.

New Building Design

Currently the only new building in design that will meet the Guiding Principles is the Science and User Support Center (SUSC) Building.

Net Zero Buildings

BNL has found it difficult to make progress on the net-zero energy building goals due to the substantial costs associated with the building design and renewable energy systems. The Brookhaven Site Office (BHSO) and DOE-HQ. BNL will continue to engage the National Laboratory community on techniques to economically meet the net-zero requirements.

For designs starting in FY20, where economically feasible, BNL will ensure net-zero requirements are included in future designs. BNL is continuing to evaluate net-zero concepts in the preliminary design of the SUSC but discussions with staff in the Science Laboratories Infrastructure (SLI) program indicate the current funding constraints will make it difficult to justify additional costs associated with achieving net zero.

Climate-Resilient Design and Management

BNL's Design Standard (Modernization Project Office [MPO] Procedure 100L) requires that all new large construction projects (new building, building addition, or Level 3 alteration) consider present and future climate conditions in assessing environmental impacts on the project. The design criteria adopts the latest version of the "Climate Resiliency Design Guidelines" prepared by the New York City Mayor's Office of Recovery and Resiliency with respect to increasing temperatures, frequency of heat waves, and precipitation. The Climate Resiliency Evaluation is to be incorporated into the design for the SUSC project.

Strategies for Design (42 USC 6834)

42 USC 6834 requires a rule revising Federal building energy efficiency performance standards to require buildings to be designed so that fossil fuel-generated energy consumption of the buildings is reduced, as compared with such energy consumption by a similar building in FY03, by various percentage reduction goals at five-year intervals. 10 CFR Part 433 "Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings" established energy efficiency performance standards for buildings which design for construction began on or after January 3, 2007. However, Subpart B "Reduction in Fossil Fuel-Generated Energy Consumption" in 10 CFR 433 is a reserved section and therefore does not define the fossil fuel-generated energy consumption reduction goals. In lieu of this requirement gap, new building construction and/or modernization will follow the Guiding Principles for Sustainable Federal Buildings to reduce energy consumption.

Acquisitions & Procurement

This category focuses on all relevant sustainable acquisition information as well as efforts to improve your supply chain GHG emissions.

Performance Status

The FY19 Sustainable Acquisition Progress tables are based on the collection method from Federal Procurement Data System (FPDS) and Office of Management and Budget (OMB)'s scorecard, and the key (below), defines each category with a crosswalk between the Federal Acquisition Regulation (FAR) Clauses (see Table 3) and the DOE Acquisition Regulations (DEAR) Clauses (see Table 4).

Category	Definition from FPDS Sustainability Report	Alignment with DEAR Clauses
Recycled	"FAR 52.223-4" + "FAR 52.223.4 & FAR 52.223-9"	DEAR 970.5223-7
Energy Efficient (EE)	"Energy Efficient"	DEAR 970.5223-7
Biobased	"Biobased"	DEAR 970.5223-7
Multi-Statutory	"FAR 52.223-4 & Energy Efficient" + "FAR 52.223-4 & Biobased" + "FAR 52.223-4 & Biobased & Energy Efficient"	DEAR 970.5223-7
Environmentally Preferable (EPP)	"Environmentally Preferable"	DEAR 970.5223-7
Statutory+	"FAR 52.223-4 & Environmentally Preferable" + "FAR 52.223- 4 & Biobased & Environmentally Preferable" + "FAR 52.223-4 & Biobased & Energy Efficient & Environmentally Preferable"	DEAR 970.5223-7

Table 3: Sustainable Acquisition Progress for FAR Contract Clauses

FY 2019 Sustainable Acquisition (SA) Progress							
Metric	**Recycled**	**EE**	**Biobased**	**Multi-Statutory**	**EPP**	**Statutory+**	**Total**
Number of Eligible Contract Actions							
Number of Contract Actions w/ SA Clauses	27019	27019	27019	27019	27019	27019	27019
Percent of Contract Actions w/ SA Clauses							

FY 2019 Sustainable Acquisition (SA) Progress							
Metric	**Recycled**	**EE**	**Biobased**	**Multi-Statutory**	**EPP**	**Statutory+**	**Total**
Total Eligible Contract Dollars ($)							
Total Contract Dollars ($) w/ SA Clauses	$230K	$230K	$230K	$230K	$230K	$230K	$230K
Percent of Contract Dollars w/ SA Clauses							

Table 4: Sustainable Acquisition Progress for DEAR Contract Clauses

FY 2019 Sustainable Acquisition (SA) Progress	
Metric	**Total**
Number of Eligible Contract Actions	27019
Number of Contract Actions w/ SA Clauses	27019
Percent of Contract Actions w/ SA Clauses	100%
Total Eligible Contract Dollars ($)	$230K
Total Contract Dollars ($) w/ SA Clauses	$230K
Percent of Contract Dollars w/ SA Clauses	$230K

Table 5: Bio-based Product Purchase and Targets (# of actions)

Fiscal Year	Number of Actions
FY19	12
FY20	12

BNL has incorporated contract clauses within its vendor contracts that designate environmentally preferred products (EPP), services, and equipment. These contract clauses include the preference of:

- Energy efficient (ENERGY STAR or FEMP-designated);
- Water efficient (WaterSense);
- Bio-based (USDA BioPreferred);
- Environmentally preferable (including Electronic Product Environmental Assessment Tool [EPEAT]-registered products);
- Non-ozone depleting (Significant New Alternative Policy [SNAP]) chemicals or other alternatives to ozone-depleting substances and high global warming potential hydrofluorocarbons;
- Recycled content, including paper containing 30% post-consumer fiber; and
- Non-toxic or less toxic alternatives products (Safer Choice labeled).

BNL uses the Vinimaya system ("E-Buy") for most purchases of BioPreferred products. The tabular matrix of commonly purchased items (based on the manufacturer's part number) that are EPP compliant has been updated with additional products. The Vinimaya system can use the manufacturer's part number and scan all of the catalogs to come up with the most efficient pricing from each vendor.

Challenges remain, as vendor information regarding recycled content for all categories is lacking, making conformance time-intensive, confusing and difficult for purchasers. BNL assists E-Buy requisitioners on request to help find conforming items and continues to develop the "Commonly Purchased Items" guide of EPP-compliant office products. The guide was developed during FY16 to help requisitioners easily select compliant E-Buy items because of the lack of information from the vendors. However, better product information from manufacturers would not only greatly improve purchasing performance, it would also save requisitioners a significant amount of time and frustration with the product selection process. BNL alone does not have the purchasing power to influence the vendors to provide the needed information.

In 2018, BNL established Environmental Management System (EMS) objectives to improve EPP purchasing performance for a wide-range of products. The efforts focused on promoting the requirements with requisitioners. The requirements continue to be communicated to E-Buy users via procurement training. The Procurement Division audits E-Buy purchases for EPP conformance, an effort directed mostly at office products. Decreasing numbers of nonconforming product purchases identified throughout the year indicates performance is improving. Procurement and Property Management (PPM) contracts include EPP purchasing performance reports from vendors, but the information received is not detailed enough to allow BNL to measure actual performance.

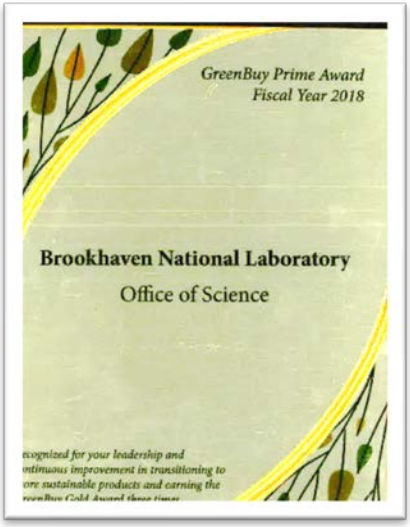
Other product/equipment categories are evaluated during various project/research design phases. For example, pre-planning for construction or major maintenance work by the Facilities & Operations (F&O) Directorate is initially screened via an Environmental, Security, Safety & Health (ESSH) Evaluation form (i.e., 500A Form), to which EPP considerations have been added. This screening step allows an opportunity to ensure that EPP contract provisions are met for all product categories, from bio-based items, low-solvent paints, energy efficiency, SNAP chemicals, recycled content building materials, office furniture, water efficient products, etc.

Bio-based purchases are tracked manually by collecting and adding together purchasing receipts.

During this past year, BNL received the "Green Electronics Council's 2019 EPEAT Purchaser Award" at the Gold Level; two "2018 DOE Federal Green Challenge" awards for waste diversion and electronics reuse and recycle; and the "2018 GreenBuy Prime" award for winning GreenBuy Gold Awards three times indicating that BNL continues to have effective processes in place to maximize or drive acquisition of sustainable products.

Green Electronics Council: 2019 EPEAT Gold Purchaser Award

2018 DOE Federal Green Challenge Award



2018 GreenBuy Prime Award

Plans and Projected Performance

During 2019, BNL will continue to develop the Commonly Ordered Items page, provide E-Buy training specific to EPP purchasing requirements, and provide support to requisitioners with questions. BNL will write new EMS objectives to promote that program and drive improvement.

BNL will also audit its EPP program during FY20 to identify areas where further purchasing improvements can be made, as well as opportunities to improve data collection to better represent current conformance.

Measures, Funding, & Training

This category focuses on efforts to implement identified Efficiency & Conservation Measures (ECM) through appropriations, performance contracts, or other funding mechanisms, and discuss provided sustainability-related training or education for employees. This section also highlights ECMs and additional funding needed beyond planned activities and typical operation costs for meeting the goal.

Performance Status

Efficiency & Conservation Measures

Internally funded energy conservation and sustainability related initiatives include a continuation of best practices, with continued emphasis on temperature setback during unoccupied periods. BNL continues to implement small lighting and water conservation projects by using the latest, most efficient equipment as part of on-going maintenance efforts.

Energy and water evaluations are completed annually per EISA 432 requirements. The information is placed into a database for BNL's use as well as into EPA's Portfolio Manager program. Potential projects are reviewed to determine if they are cost-effective. Small cost-effective projects are sometimes implemented with operating funds. When larger cost-effective projects are identified they will be directed for potential inclusion in BNL's UESC II project currently in development.

Energy Performance Contracts

As indicated in previous sections, BNL completed its first UESC in 2015. The project continues to perform well, meeting the original energy savings estimates within a few percent each year. As a result of the success of this project, a second UESC is being developed. The Investment Grade Audit (IGA) was complete at the end of FY19. Lessons learned from the first project, UESC Phase I, are being included with the UESC Phase II effort.

A Performance Assurance Plan (PAP) will be included with the UESC II project. The plan developed in the recent IGA is similar to the M&V program included with the first UESC effort, but important lessons learned have been incorporated regarding how data is collected and analyzed.

Funding

Funding continues to be difficult for energy conservation and sustainability related projects in the current budget constrained environment. BNL, like other DOE sites, has been increasingly using third party financing options that utilize cost savings to pay for the projects. However, while BNL is extremely fortunate to have low energy rates to operate its' research programs, it makes it difficult to find cost-effective projects.

Table 6: Sustainability Funding

Category	FY19 Actual	FY20 Planned/ Request	FY21 Projected
Sustainability Projects*	44	200	650
Sustainability Activities other than projects	0	0	0
SPO Funded Projects (SPO funding portion only)	0	0	0
Site Contribution to SPO Funded Project	0	0	0
ESPC/UESC Contract Payments (if applicable)	1,551	1,597	1,645
Renewable Energy Credits (REC) Purchase Costs (if applicable)	18.8	34	35
Total	1,613	1,831	2,330

Training

The manager of Energy Management at BNL and the Data Center manager are Certified Energy Managers (CEM's). In addition, all of the Facility Complex Managers throughout the BNL campus have the Certified Facility Manager (CFM) recognition from the International Facilities Management Association. All of the Facility Complex Managers and Facility Complex Engineers participate in various training programs throughout the year to ensure core competencies.

Additionally, numerous employees attend training programs to maintain their professional certifications including PE, CEM, Green Professional, LEED, and many others.

Plans and Projected Performance

As previously indicated, BNL is in the process of developing a UESC Phase II project that will include energy conservation measures for lighting, HVAC, and controls, a water side economizer, and rebalancing of BNL's most energy intensive building, Chemistry. The recently completed IGA estimates the energy savings at 36,354 mmBtu/year for a reduction of 22% from the total affected building baseline.

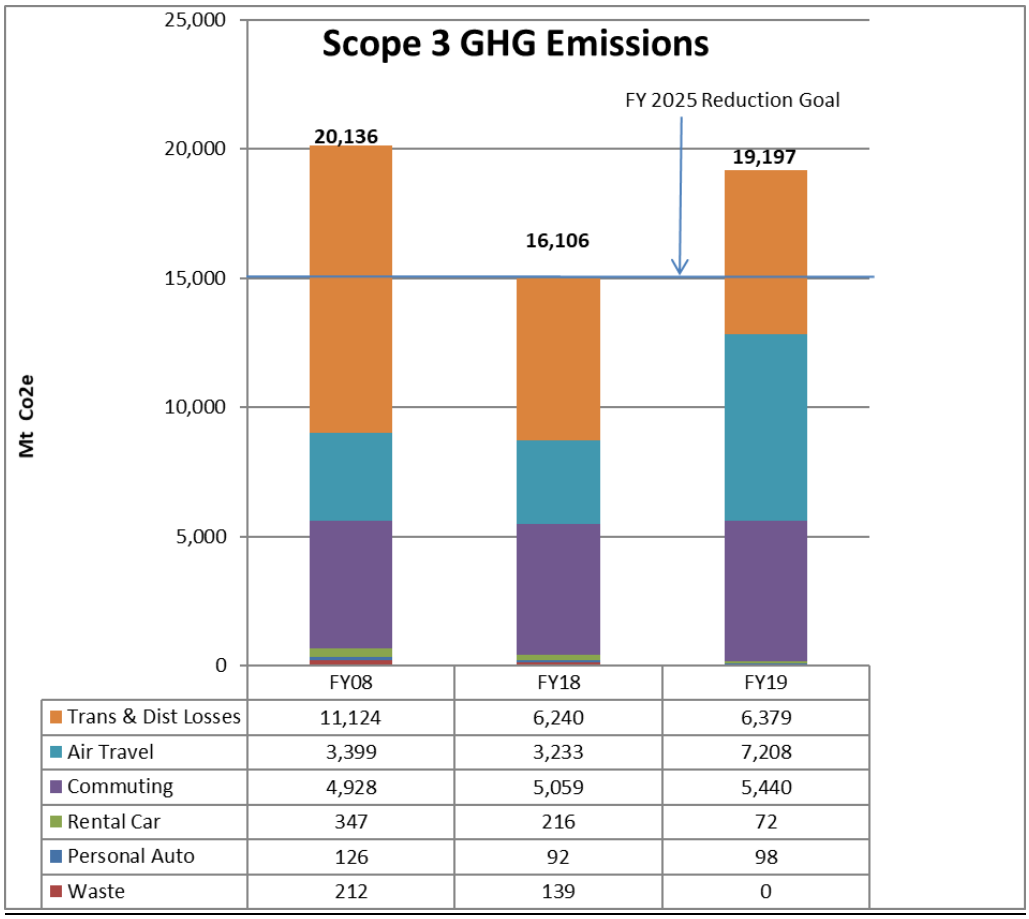
The economics of this potential second UESC II effort are less cost-effective than the previous UESC. BNL management is currently evaluating the project and will make a decision regarding whether or not to move forward in early FY20.

Travel & Commute

This category focuses on all information pertaining to the site's business travel and commute data, including participation in regional and local planning.

Performance Status

BNL continues to track its Scope 3 Greenhouse Gas Emissions in relation to the previously established Scope 3 Greenhouse Gas Reduction Goal established under Executive Order 13514. Figure 9 below illustrates that, overall Scope 3 emissions are up 19.2% from FY18 (16,106 MtCO2e), and 4.7% lower than the FY08 baseline value.



	FY08	FY18	FY19
Trans & Dist Losses	11,124	6,240	6,379
Air Travel	3,399	3,233	7,208
Commuting	4,928	5,059	5,440
Rental Car	347	216	72
Personal Auto	126	92	98
Waste	212	139	0

Figure 9: Scope 3 GHG Emissions

The increase from FY18 is largely due to a 3,975 MT CO_2e jump in air travel GHG emissions and, to a lesser extent, a 380 MT CO_2e rise in commuting GHGs. The increase in commuting GHG emissions from 2018 was due in part to a 4.5 % increase in the average daily number of commuters and adjustments to the relative percentages of employee passenger vehicles and light duty vehicles to match those in the Safeguards & Security Division's Vehicle Registration Database.

FY19 commuting GHG emissions were estimated using employee residency zip code records to determine the average employee round trip commute distance and past results from an April 2016 gate survey. The survey employed a combination of automatic traffic counters and personnel to record the numbers and types of single occupant vehicles and carpools entering the site during the morning commute hours.

BNL participated in the Annual Car Free Day Long Island (LI) celebration on September 20, 2019 to increase employee awareness and appreciation of the environmental, health, and economic benefits of sustainable means of transportation. To participate, employees completed a pledge on the Car Free Day LI website to be car-free or car-lite on September 20 and commit to drive less by carpooling, biking, walking, or telecommuting.

To promote Car Free Day and to encourage employees to participate, information describing the event was posted on BNLs homepage and in the "Brookhaven This Week" email newsletter. In addition, BNL's Environmental Protection Division and a representative of the 511NY Rideshare Program hosted a table by the entrance to the cafeteria on September 20 to provide information to employees on BNL's rideshare program. Twenty employees made pledges to be car-free or car lite.

BNL's Information Technology Division offers a variety of video and audio-conferencing services that enable personnel to communicate and collaborate with off-site personnel remotely thereby reducing business travel for offsite meetings. Video conferencing options include video collaboration utilizing the Blue Jeans cloud-based tool or two separate video conferencing rooms that can accommodate 12 and 70 persons respectively. Three 12-port and two 6-port audio conferencing bridge lines are currently available free for BNL end-users.

Regional and Local Planning

BNL continues to maintain close interaction with NY State, the Metropolitan Transportation Authority (MTA), Long Island Rail Road (LIRR) and Suffolk County and Brookhaven Town officials regarding plans for relocation of the Yaphank rail station to become a Yaphank/BNL rail station that is in closer proximity to BNL and public transportation arteries. NY State budgeted $20M for relocation of the Yaphank rail station and a planning study for the relocated station was recently completed.

The scope of the study includes planning for a station that would be more easily accessible for the general public, BNL and potential public bus routes and vehicle access along the William Floyd Parkway corridor. The scope includes provisions for potential electrification of the rail line and capability for up to 3 platforms of 12 cars each. This potential electrification would make the Yaphank/BNL station the Eastern terminus of the LIRR Ronkonkoma electrified line and relieve some of the congestion at the Ronkonkoma station. A station with more frequent electrified service within a mile of BNL (in conjunction with public bus routes or shuttle service) would make commuting by public transportation a viable option for BNL employees and make work at BNL attractive for New York City residents. The relocated station would also make travel to/from regional airports (JFK, Laguardia, Islip) much more convenient for the thousands of researchers visiting BNL annually from all over the United States and the world.

Plans and Projected Performance

Combined electricity purchases of conventional power and hydropower are expected to rise 20.6% from the FY19 total to 338,800 MWh in FY25. Using eGrid 2016 transmission and distribution (T&D) loss factors and Northeast Power Coordinating Council, Inc. (NPCC) Long Island total output and NPCC Upstate non-baseload output emission rates, estimated T&D GHG emission will increase to 6,936 MtCO2e in FY25.

Regional and Local Planning

The Discovery Park development continues to make excellent progress. The Science and User Support Center (SUSC) is the Federally funded anchor for the Discovery Park development received first year funding in FY19 and design of the facility is now underway. Development of standard ground lease requirements are underway to enable start of private funded development at Discovery Park in parallel with the SUSC. Initial agreements for utility services to Discovery Park have been reached to enable finalization and installation as needed to support development. The initial phase of development of Discovery Park, called Upton Square, would include the SUSC, a dormitory-like housing facility and a possible education center. These three facilities would largely serve existing BNL staff and visitors and have little to no impact on local traffic. The later phases of Discovery Park development would include creation of technology partnership facilities which could bring in an additional 1200 to 1500 daily visitors to BNL when fully built-out. This added traffic demand will be discussed with Suffolk County (Wm Floyd Pkwy) and Brookhaven Town (Longwood Road) and be evaluated as part of the National Environmental Policy Act (NEPA) process for the technology partnership area development. Note that the potential Yaphank/BNL commuter rail station discussed above could significantly reduce the number of vehicles coming to BNL from current values.

Fugitives & Refrigerants

This category focuses on all fugitive emissions or refrigerants used at the site and any efforts (current and/or planned) to reduce or minimize GHG emissions (along related challenges or opportunities).

Performance Status

Fugitive and Refrigerant GHG Emissions

A variety of activities and operations at BNL use greenhouse gases for different purposes. The largest user of greenhouse gases at BNL is the Tandem Van de Graaff Facility. The two Tandem accelerator vessels with a combined storage volume of 16,050 ft^3 are filled with an insulating gas mixture consisting of 46%v SF_6, 44%v N_2, 6%v CO_2, and 4%v O_2. Annually, there are some emissions of SF_6 and CO_2 due to insulating gas leaks and the transfer of insulating gases during periodic maintenance of the Tandem accelerators.

Tandem Van de Graaff Facility

The table below provides a summary of the sources of BNL fugitive greenhouse gas emissions in FY19.

Table 7: Fugitive GHG Emissions

Source	Activity	Gas	GHG Emissions ($MtCO_2e$)
Tandem Van de Graff	Insulating gas leaks	SF_6	3,940.78
		CO_2	0.01
	Accelerator gas transfers	SF_6	24.20
STAR Experiment	Detector gas purging	CH4	7.16
		CO_2	0.00
		HFC-134a	1,051.57
		SF_6	42.40
Fleet Vehicle Repair	Fleet Motor Vehicle A/C Leaks	HFC-134a	20.11
Whole Site		CO_2	0.01
Refrigeration/AC Equipment	Gas Leaks	HFC-134a	19.46
		R-404A	5.34
		R-410A	52.37

The bulk of BNL's process and fugitive GHG emissions (besides those from insulating gas leaks of SF_6 from the Tandem Van de Graaff accelerator vessels) were due to periodic purging of carrier gases used in STAR detector subsystems during the FY 2019 Relativistic Heavy Ion Collider experimental run. The recirculation system on the STAR multi-gap resistive plate time of flight (TOF) subsystem reduced purged gas releases of HFC-134a by 86.5% throughout the experimental run (208.14 $MtCO_2e$).

On June 4, the Environmental Protection Division worked with F&O Production Division staff to conduct a joint self-audit of their Refrigerant Management Program to identify actions that may be taken improve the program, and to address any program gaps and deficiencies.

Preventative maintenance inspections of four 2.4 kilovolt (kV) & thirteen 13.8 kV sulfur hexafluoride (SF_6) gas insulated switches, plus four 69 kV SF_6 gas insulated circuit breakers were conducted in FY 2019 as part of BNL's proactive program to identify and mitigate leaks of the Laboratory's SF_6 gas insulated high-energy equipment. Recorded equipment temperature readings and pressure gauge readings during the inspection provided no evidence of SF_6 leaks.

Plans and Projected Performance

Job plans for the next scheduled preventative maintenance inspections of SF_6 gas insulated switches and circuit breakers will be released on April 1, 2020. Annual preventative maintenance inspections will also be released on April 1, in concurrence with the job plans.

Electronic Stewardship

This category focuses on the acquisition, operations and management, and disposal techniques of all electronics reported, as well as data centers efficiency improvements.

Performance Status

Acquisition/Operations

The Laboratory requires that all printers, laptops, and desktop computers ordered through the E-Pro system have an EPEAT "Gold" certification.

During FY19 the Laboratory procured printer management software that will help remotely manage printers and will allow the Lab to enforce duplex printing as a default setting when the printer supports it.

BNL evaluated the feasibility of extending the desktop computer power management policy to other operating systems. This activity will not be continued, going forward.

End of Life

BNL tracks computer components through its PeopleSoft program to ensure full utilization of these products throughout their lifespans. The average age of a BNL computer prior to disposal is approximately six years, which is 50% above the average retirement age of four years.

Usable computers and peripherals are sent to an on-site warehouse where departments can go to acquire computers as needed. Last year, approximately 964 desktop computers, 244 laptops, 48 tablets and 41 servers were reused internally by BNL personnel as well as numerous other small electronics.

New York State environmental regulations prohibit household electronic waste (E-Waste) to be disposed of with municipal solid waste (household trash) and requires that home owners dispose of their E-Waste through Town specified collection points, usually located at solid waste transfer stations. As an incentive for employees to dispose of their E-Waste in an environmentally acceptable manner, while easing the burden of finding and scheduling a time to travel to a transfer station, BNL held two employee household E-Waste collection days during the year. Information is supplied to employees on how to sanitize and/or remove their computer hard drives to avoid personal information from getting into the open domain. BNL considers these events an effective means of communicating environmentally-friendly disposal practices to all staff. Proof is seen by the popularity of these collection days.

BNL held two employee household E-Waste collection days during the year

Figure 10 below summarizes the amount of electronic equipment that has been recycled annually by BNL since 2006.

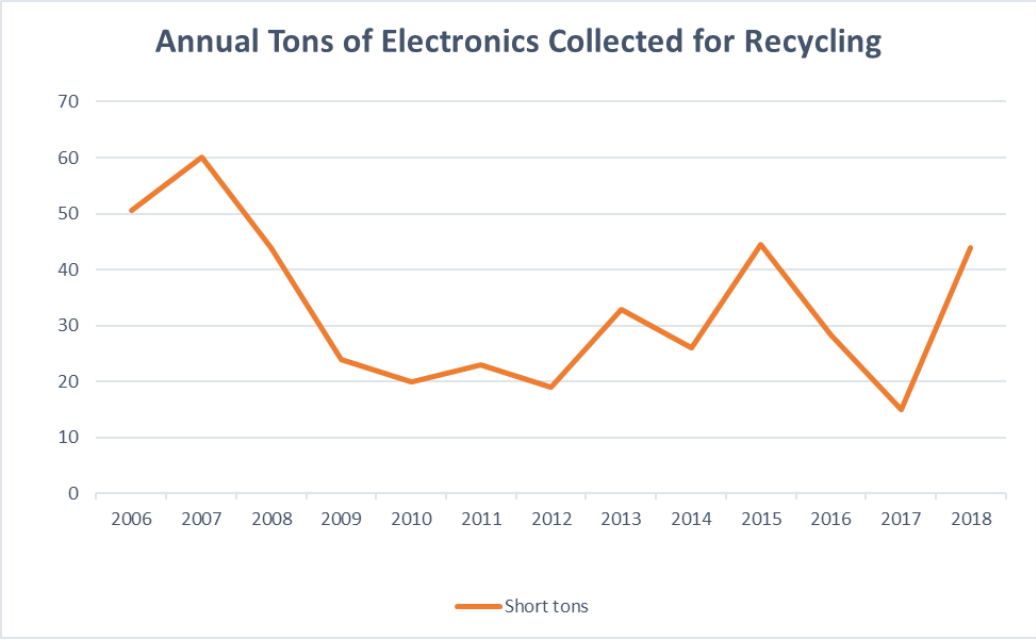


Figure 10: Annual Tons of Electronics Collected for Recycling

Data Centers

Existing Data Centers

BNL completed an evaluation of its existing data centers in response to the Data Center Optimization Initiative (DCOI) from the summer of 2016. The internal assessment identified eight (8) data centers that meet the new DCOI criteria. Previously, BNL had two (2) data centers based on the former definition. A comprehensive assessment has yet to be completed but it is clear that additional resources will be needed to meet the goal of a PUE < 1.5. Four of the eight data centers will require the installation of additional metering in order to determine the actual PUE.

New Data Centers

The data center associated with the CFR project is currently in the construction phase. Preliminary preparation began in June 2019. The completed CFR is targeting a PUE of < 1.3 in accordance with the recent DCOI.

Plans and Projected Performance

Acquisition/Operations

The Laboratory will continue to require that all printers, laptops, and desktop computers ordered through the E-Pro system have an EPEAT "Gold" certification.

Since procuring the printer management software, going forward in FY20, BNL will utilize this software to help remotely manage printers and enforce duplex printing as a default setting when the printer supports it. This new software will replace the old print servers. ITD is in the process of implementing the software and migrating printers.

End of Life

BNL will continue to dispose of electronic waste in an environmentally sound manner through a certified R2 recycler. However, electronics collected internally will be tracked separately from home collections in order to clarify internal generation rates and to help monitor the effectiveness of the home collection days.

Data Centers

Existing Data Centers

Meeting the PUE of 1.5 for the existing data centers will require a significant investment. Further, four of the eight existing data centers will require the installation of new metering, which is partially in progress.

BNL will work to identify the actions and resources needed to meet the PUE 1.5 requirement for the eight existing data centers and if cost effective, begin the process of obtaining potential funding. The first effort will focus on determining the most cost effective metering on four of the data centers that are currently not metered in order to determine their actual PUE.

New Data Centers

The data center associated with the CFR project is in the design phase and is targeting a PUE of < 1.3 in accordance with the recent DCOI. The CFR project received CD-2 approval and started construction in June of 2019, with an projected completion of 2023.

Resilience

This category focuses on resilience-related topics. Organizational resilience is the ability of an agency to adapt to changing conditions and withstand or recover from disruption. Resilience efforts help sites manage risks to DOE assets, infrastructure, and operations.

Performance Status

Resilience Strategies

During FY19 BNL's Office of Emergency Management (OEM) conducted a Loss of Power exercise specific to F&O to identify gaps or concerns regarding electrical power issues. OEM also performed two accountability exercises for all employees. Accountability exercises are performed on a quarterly basis and are required by the Department of Energy on behalf of the Office of Human Capital. OEM streamlined the exercises and fine-tuned the methodology to account for BNL employees.

OEM maintains the Continuity of Operations Plan (COOP) and meets with the Continuity of Emergency Response Group (CERG) annually to discuss the specific mission essential functions at BNL. OEM also maintains specific plans such as the Pandemic/Influenza, Power Outage, Severe Weather, Hurricane, and Emergency plans.

The Essential Personnel webpage was updated to include a new interface. The new interface allows individual employees to view their current status. Designated essential personnel coordinators can now use one link to view or add personnel. The link is also tied to PeopleSoft, allowing for automatic updates and deleting employees whom are no longer employed.

Plans and Projected Performance

Resilience Strategies

The All Hazards Survey is scheduled for an update in FY20. Accountability exercises will continue to be performed on a quarterly basis, as required by the Department of Energy on behalf of the Office of Human Capital. OEM will continue to maintain the COOP as well as other specific emergency plans (i.e. Pandemic/Influenza Plan, Power Outage Plan, Severe Weather Plan, Hurricane Plan, Emergency Plan).

Appendix A: Dashboard Data Accuracy Self-Certification

Self-Certification of the Dashboard

BNL has utilized the built-in approval process within DOE's Sustainability Dashboard to certify the accuracy and completeness of the data submission.

Appendix B: Excluded Buildings Self-Certification Process

Self-Certification of Excluded Buildings

BNL has utilized the built-in approval process within DOE's Sustainability Dashboard to certify the FY19 Excluded Buildings List.

Appendix C: Comprehensive Scorecard

Facility Management

Energy Intensity

Goal: The latest energy intensity reduction goal, requires a reduction in energy intensity for goal subject facilities by 25 percent by FY 2025 relative to FY 2015 baseline. The prior goal, required a 30 percent reduction by FY 2015 relative to FY 2003 baseline
Interim Target (FY 2019): -10.0%

Current Performance: 259.6%

	FY 2015	FY 2019	% Change
Purchased Utilities (MMBtu)	16,141,274.9	56,099,895.0	247.6%
Purchased Renewables (MMBtu)	0.0	406,570.8	N/A%
Goal-subject GSF	110,759,593.0	107,822,085.0	-2.7%
Energy Intensity (Btu/GSF)	**145,732.5**	**524,071.3**	**259.6%**

EISA S432 Compliance

Goal: Reduce per-mile greenhouse gas emissions by 30 percent by FY 2025 relative to FY 2014 baseline

Current Performance: At Risk of Compliance

	Due Date	Covered Energy	Evaluated Square Footage Status	# of Covered Facilities Benchmarked
Current Evaluation Cycle Status	N/A	119.42% 27,535,744.65 MMBtu	Completed: 23,419,330 Remaining: 51,221,275	0 out of 2592

	# of Identified ECMs	# of Awarded/Funding Approved ECMs	# of implemented ECMs with reported M&V data	$ value of all implemented ECMs
Current Evaluation Findings	412	41	6	1,229,414,830

Renewable Electricity

Goal: Use 30 percent renewable energy as a percentage of overall facility electricity use by FY 2025
Interim Target (FY 2019): 15%

Current Performance: 10.1%

	FY 2019 Electricity Consumption	FY 2019 Renewable Electricity w/ Bonuses	% of Total
Grid Electricity	21,138,804	0.0	N/A
On-Site Renewable Energy	3,653	1,484,740	7.0%
Purchased Green Electricity	119,159	222,363	1.0%
Renewable Energy Certificates	N/A	440,363	2.1%
Total (MWh)	**21,261,616**	**2,147,466**	**10.1%**

Potable Water Intensity

Goal: Reduce water intensity by 36 percent by FY 2025 relative to FY 2007 baseline
Interim Target (FY 2019): -24.0%

Current Performance: 487.2%

	FY 2007	FY 2019	% Change
Water Consumption (million gal)	8,688.9	50,801.1	484.7%
Aquifer Recharge (million gal)	322.1	313.2	-2.8%
Total GSF	122,416,890.0	125,790,578.0	2.8%
Water Intensity (Gal/GSF)	**68.3**	**401.4**	**487.7%**

Clean Energy

Goal: By FY 2025, use 25 percent renewable energy as a percentage of overall facility electric and thermal energy use.
Interim Target (FY 2019): 0.0%

Current Performance: 6.0%

	FY 2019 Energy Consumption	FY 2019 Clean Energy w/ Bonuses	% of Total
Grid Electricity	72,593,222	0.0	N/A
Non-renewable Thermal Energy	36,869,379	0.0	N/A
On-Site Renewable Energy	57,185	4,153,781	7,263.7%
Purchased Green Electricity	406,571	406,571	100.0%
Renewable Energy Certificates	N/A	1,502,519	N/A
Total (MMBtu)	**109,926,357**	**6,062,871**	**5.5%**

Non-Potable Water Consumption

Goal: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline.
Interim Target (FY 2019): -18.0%

Current Performance: -50.4%

	FY 2010	FY 2019	% Change
Industrial	3,171.3	1,455.0	-54.1%
Landscaping	143.3	187.9	31.1%
Agricultural	0.0	0.0	N/A%
Total Non-Potable Water (million gal)	**3,314.6**	**1,642.9**	**-50.4%**

Sustainable Buildings

Goal: Ensure 17 percent by building count comply with the Guiding Principles for sustainable buildings by FY 2025. Interim Target (FY 2017): 15.0 %
Interim Target (FY 2019): 15.5%

Current Performance: 7.4%

	Building Count	GSF
Guiding Principles Certified	210	8,064,419
Total Applicable*	2,826	102,534,769
Performance (%)	**7.43%**	**7.87%**

* Applicable means buildings and trailers that are DOE owned or DOE leased where the gross/rentable SqFt is greater than 5,000.

Fleet Management

Fleet Petroleum

Goal: Reduce fleet petroleum use by 20 percent by FY 2015 and thereafter relative to FY 2005 baseline
Interim Target (FY 2019): -20.0%

Current Performance: -100.0%

	FY 2005	FY 2019	% Change
Gasoline	5,488,033	0	-100.0%
Diesel	1,751,377	0	-100.0%
Biodiesel*	162,050	0	-100.0%
Total Petroleum (GGE)	**7,401,460**	**0**	**-100.0%**

* Includes only the diesel content of B20

Fleet Alternative Fuel

Goal: Increase fleet alternative fuel use by 10 percent by FY 2015 and thereafter relative to FY 2005 baseline
Interim Target (FY 2019): 10.0%

Current Performance: 0.0%

	FY 2005	FY 2019	% Change
E-85	401,903	0	-100.0%
Biodiesel*	102,852	0	-100.0%
CNG	69,914	0	-100.0%
Other*	50,035	0	-100.0%
Total Alternative (GGE)	**624,704**	**0**	**-100.0%**

* Biodiesel contains B100 plus the biodiesel content from B20. Other contains LNG, LPG, and electric

Fleet Greenhouse Gas Emissions/Mile

Goal: Reduce potable water intensity by 36 percent by FY 2025 relative to FY 2007 baseline.
Interim Target (FY 2019): -18.0%

Current Performance: -50.4%

	FY 2014	FY 2019	% Change
Fleet Fuel GHG (MtCO2e)	56.5	0.0	-100.0%
Fleet Miles (x1000)	78,187.4	0.0	-100.0%
Greenhouse Gas Emissions / Mile (gCO2e/Mile)	**1.0**	**0.0**	**-100.0%**

Waste Management

Municipal Solid Waste

Goal: Divert at least 50 percent of non-hazardous solid waste (excluding construction and demolition debris)
Interim Target (FY 2019): 50.0%

Current Performance: 68.3%

	FY 2019	%
Off-Site Landfills	19,162.6	24.7%
On-Site Landfills	4,273.6	5.5%
Waste to Energy*	1,166.2	1.5%
Non-diverted Waste	***24,602.4***	***31.7%***
Diverted Waste	41,748.7	53.8%
On-Site Composted	6,685.3	8.6%
Off-Site Composted	3,737.3	4.8%
Waste to Energy Credit	877.1	1.1%
Total Diverted Waste	***53,048.3***	***68.3%***
Total Waste (metric tons)	**77,650.8**	**100.0%**

* For E.O. 13693, waste to energy does not count as diverted waste, but some credit may be applied

Construction & Demolition

Goal: Divert at least 50 percent of construction and demolition materials and debris
Interim Target (FY 2019): 50.0%

Current Performance: 64.4%

	FY 2019	%
Landfilled C&D Waste	143,386.9	35.6%
Diverted C&D Waste	258,927.1	64.4%
Total C&D Waste (metric tons)	**402,314.1**	**100.0%**

Electronics Stewardship

Electronics Acquisition

Goal: 100 percent of eligible electronics procurements must be environmentally sustainable (e.g. EPEAT)
Interim Target (FY 2019): 95.0%

Current Performance: 93.9%

	EPEAT Acquired	Total Acquired	%
Monitors	38,140	42,765	89.2%
Computers	52,094	53,020	98.3%
Imaging Equipment	4,332	4,684	92.5%
Televisions	503	875	57.5%
Total Acquired	**105,624**	**112,444**	**93.9%**

Electronics Recycling

Goal: Dispose of 100 percent of electronics through government programs and certified recyclers
Interim Target (FY 2019): 100.0%

Current Performance: 99.6%

	Amount	%
Transferred or Donated	322.787	21.6%
Recycled by Certified Recycler	1,104.857	74.0%
Recycled by non-Certified Recycler	60.668	4.1%
Amount disposed (e.g. landfill)	5.707	0.4%
Total Electronics Waste (metric tons)	**1,494.019**	**100.0%**

Power Management

Goal: Implement and actively use power management features on 100 percent of eligible computers (PCs & laptops) and monitors
Interim Target (FY 2019): 100.0%

Current Performance: 99.0%

	Total Owned	PM Enabled	Exempt	%
Monitors	265,073	243,121	21,454	99.8%
Computers	206,578	171,748	31,123	97.9%
Total Items	**471,651**	**414,869**	**52,577**	**99.0%**

Duplex Printing

Goal: Implement and actively use duplex printing features of 100 percent of eligible printers
Interim Target (FY 2019): 100.0%

Current Performance: 76.8%

	Total Owned	Duplex Enabled	Incapable	%
Total Printers	**30,427**	**19,069**	**5,602**	**76.8%**

Acquisition

Sustainable Acquisition

Goal: Ensure 95 percent of new contract actions for products and services meet sustainable acquisition requirements
Interim Target (FY 2019): 95.0%

Current Performance: 193.2%

	Contracts Reviewed	Contracts Without Opportunity	Contracts Meeting All Requirements	%
Number of Contracts	**7,708**	**3,744**	**7,660**	**193.2%**

Greenhouse Gas Management

Scope 1 & 2 Greenhouse Gas Emissions

Goal: Reduce direct GHG emissions by 50 percent by FY 2025 relative to FY 2008 baseline
Interim Target (FY 2019): -31.0%

Current Performance: 243.4%

	FY 2008	FY 2019	% Change
Facility Energy	3,773,959.1	16,166,870.4	328.4%
Non-Fleet V&E Fuel	41,351.3	100,698.0	143.5%
Fleet Fuel	67,084.6	0.0	-100.0%
Fugitive Emissions	798,987.1	177,109.5	-77.8%
On-Site Landfills	27,219.0	24,449.3	-10.2%
On-Site WWT	1,405.5	1,443.6	2.7%
Renewables	0.8	2,603.8	325,375.0%
RECs	0.0	-297,739.7	N/A
Total (MtCO2e)	**4,710,007.4**	**16,175,434.8**	**243.4%**

Scope 3 Greenhouse Gas Emissions

Goal: Reduce indirect GHG emissions by 25 percent by FY 2025 relative to FY 2008 baseline
Interim Target (FY 2019): -13.0%

Current Performance: 63.6%

	FY 2008	FY 2019	% Change
T&D Losses*	186,630.4	662,901.3	255.2%
T&D RECs Credit	0.0	-16,121.7	N/A
Air Travel	146,811.1	145,244.5	-1.1%
Ground Travel	23,614.8	63,429.8	168.6%
Commute	420,273.9	427,055.8	1.6%
Off-Site MSW	16,931.1	17,273.9	2.0%
Off-Site WWT	430.0	309.1	-28.1%
Total (MtCO2e)	**794,691.3**	**1,300,092.7**	**63.6%**

* Includes T&D losses for purchased renewable electricity

Appendix D: List of Acronyms & Abbreviations

AGS	Alternating Gradient Synchrotron
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ATF	Accelerator Test Facility
BAS	Building Automation System
BHSO	Brookhaven Site Office
BLCC	Building Life-Cycle Cost
BNL	Brookhaven National Laboratory
BMP	Best Management Practice
BORE	Beneficial Occupancy Readiness Evaluation
BSA	Brookhaven Science Associates
Btu	British thermal unit
C&D	Construction & Demolition Debris
C-AD	Collider-Accelerator Department
CAFE	Corporate Average Fuel Economy
CD	Critical Decision
CEM	Certified Energy Manager
CERG	Continuity of Emergency Response Group
CERN	European Organization for Nuclear Research
CFL	Computers for Learning
CFM	Certified Facility Manager
CFN	Center for Functional Nanomaterials
CFR	Code of Federal Regulations
CFR	Core Facility Revitalization
CHP	Combined Heat and Power
CLCPA	Climate Leadership and Community Projection Act
CMS	Chemical Management System
COOP	Continuity of Operations Plan
CSF	Central Steam Facility
CSI	Computational Science Initiative
DCOI	Data Center Optimization Initiative
DOE	Department of Energy
ECM	Efficiency & Conservation Measures
EIC	Electron-ion collider
EHSS	Office of Environment, Health, Safety & Security
EISA	Energy Independence and Security Act
EMS	Environmental Management System
EO	Executive Order
EPA	Environmental Protection Agency
EPEAT	Electronic Product Environmental Assessment Tool
EPP	Environmentally Preferable Purchasing
ESCO	Energy Service Company
ESPC	Energy Savings Performance Contract
ESSH	Environmental, Security, Safety & Health

EU	Energy & Utilities
EUI	Energy Utilization Index
F&O	Facilities and Operations
FAA	Federal Aviation Administration
FCA	Facility Condition Assessment
FCE	Facility Complex Engineer
FCM	Facility Complex Manager
FEMP	Federal Energy Management Program
FIMS	Federal Information Management System
FPDS	Federal Procurement Data System
FY	fiscal year
gal	gallons
GHG	Greenhouse Gas
GOCO	Government-Owned, Contractor-Operated
GP	Guiding Principle
gpf	gallons per flush
GPM	Gallons Per Mile
GSA	U.S. General Services Administration
gsf	gross square feet
HASP	Health and Safety Plan
HEMSF	High-Energy Mission-Specific Facility
HFC	hydrofluorocarbon
HPC	High-Performance Computing
HPSB	High Performance Sustainable Buildings
HQ	Headquarters
HR	Human Resources
HVAC	heating, ventilation, and air-conditioning systems
IESNA	Illuminating Engineering Society of North America
IFM	Integrated Facility Management
IFMA	International Facilities Management Association
IGA	Investment Grade Audit
IGPP	Institutional General Plant Projects
ILA	industrial, landscaping, and agricultural
ISB-I	Interdisciplinary Science Building I
ITD	Information Technology Division
JFK	John F. Kennedy International Airport
kV	kilovolt
kW	kilowatt
kWh/yr	kilowatt hour per year
LCC	Life-Cycle Cost
LDT	light-duty truck
LEED	Leadership in Energy & Environmental Design
LI	Long Island
LINAC	linear accelerator
LIPA	Long Island Power Authority
LIRR	Long Island Railroad
LISF	Long Island Solar Farm
LOB	Laboratory Office Building

M&V	measurement and verification
mmBtu	one million Btu
MPO	Modernization Project Office
MTA	Metropolitan Transportation Authority
$MtCO_2e$	metric tons of carbon dioxide equivalent
MW	megawatts
MWh	megawatt hours
NEPA	National Environmental Policy Act
NPCC	Northeast Power Coordinating Council, Inc.
NREL	National Renewable Energy Laboratory
NSERC	Northeast Solar Energy Research Center
NSLS-I	National Synchrotron Light Source
NSLS-II	National Synchrotron Light Source II
NYC	New York City
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
ODS	ozone depleting substance
OEM	Office of Emergency Management
OH&P	Overhead and Profit
OMB	Office of Management and Budget
PA	Preliminary Assessment
PAP	Performance Assurance Plan
PE	Professional Engineer
PFC	perfluorocarbon
PHENIX	Pioneering High Energy Nuclear Interaction Experiment
PM	preventative maintenance
PPM	Procurement and Property Management
PSC	Public Service Commission
PUE	power utilization effectiveness
PV	photovoltaic
RACF	RHIC ATLAS Computing Facility
RCA	recycled concrete aggregate
RE	Renewable Energy
REC	Renewable Energy Credit
RFP	Request for Proposals
RHIC	Relativistic Heavy Ion Collider
SC	Office of Science
SF_6	Sulfur Hexafluoride
SLI	Science Laboratories Infrastructure
SNAP	Significant New Alternative Policy
SPO	Sustainability Performance Office
SSP	Site Sustainability Plan
STAR	Solenoidal Tracker at RHIC
STP	Sewage Treatment Plant
SUF	Service Usage Forms
SUSC	Science User Support Center
SWP	Safe Work Plan

T&D	Transmission & Distribution
TEC	total estimated cost
THIRA	Threat and Hazard Identification and Risk Assessment
TOF	time of flight
UESC	Utility Energy Service Contract
USDA	U.S. Department of Agriculture
WWII	World War II