

# THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY FY 2020 SITE SUSTAINABILITY PLAN

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**U.S. Department of Energy  
Sustainability Performance Division**

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## Executive Summary

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The Thomas Jefferson National Accelerator Facility (Jefferson Lab), located in Newport News, Virginia, is a laboratory operated by Jefferson Science Associates, LLC for the Department of Energy's (DOE) Office of Science (SC). The primary mission of the laboratory is to explore the fundamental nature of confined states of quarks and gluons, including the nucleons that comprise the mass of the visible universe. Jefferson Lab also is a world-leader in the development of the superconducting radio-frequency (SRF) technology utilized for the Continuous Electron Beam Accelerator Facility (CEBAF).

Jefferson Lab has achieved significant progress and remains on target to meet or exceed both interim and long term sustainability goals for scopes 1, 2, and 3 greenhouse gas (GHG) emissions, data center power utilization effectiveness (PUE), renewable and clean energy use, fleet, waste, electronics, and acquisition goal categories. Strategies have been identified and are in progress to achieve other significant sustainability goals including energy intensity, high performance sustainable building (HPSB) guiding principles, and water intensity goals as defined in the DOE Strategic Sustainability Performance Plan (SSPP). Jefferson Lab sustainability goals are integrated into the Environmental Management System (EMS) in accordance with DOE O 436.1 Department Sustainability.

In FY17, Jefferson Lab completed a major data center consolidation and renovation project that included a significant central chiller plant upgrade and continuous PUE monitoring energy dashboard. This project included consolidation of a tier III data center operating at a PUE of 2.44 and renovation and reconfiguration of a tier I data center operating at a PUE of 1.70. As a result of the combined high performance and core computing data centers, a new average PUE of 1.30 was achieved. Data center operational efficiency achievements were recognized in FY18 with a Federal Energy and Water Management Award in the data center category.



As a high energy mission specific facility (HEMSF), Jefferson Lab's recent expansion of scientific and support facilities will result in significantly increased electrical and thermal energy requirements. Consequently, achievement of the SSPP scope 2 emission reduction target (purchased electricity) represents a significant challenge. Electricity requirements and related power costs for 12 GeV operations starting in FY18 are projected to increase approximately 80% from the FY08 baseline.

Major reduction of scope 2 GHG emissions from purchased electricity requires implementation of a combined set of strategies including:

- Renewable energy credits and/or green power purchasing agreement
- Electric utility renewable portfolio standard achievement of reduced GHG emissions per Mwh of electric generation
- Regional alternative electric energy supply and/or on-site low GHG electricity generation

As the scientific mission continues to expand, thermal energy (cooling tower water) requirements for accelerator operations are also projected to significantly increase. Similar to the projected electricity increases from 12 GeV operations, water requirements are estimated to increase approximately 75% from the FY07 baseline of 50 MGal. Approximately 85% of annual consumption of potable water is primarily consumed in cooling tower operations (evaporation/blow down).

Multiple alternative water reduction strategies are under consideration. Independent consulting firms and a water assessment team from Pacific Northwest National Laboratory (PNNL) conducted on-site water consumption analysis surveys. Water intensity reduction plans are focused on providing alternative water sources to primarily satisfy thermal energy (cooling tower water) requirements. Water efficiency strategies include ultra-pure water (UPW) system discharge, capture, and reuse which was successfully implemented in FY19. This project was designed to reuse the UPW reject water for cooling tower makeup, and will save approximately 5 MGal of potable water per year. A combination of additional strategies (reuse, rain water harvesting, and domestic water reductions), however, are required to achieve the challenging goal of 36% water reduction by FY25.

Prior DOE Goal	Current Performance Status	2 Year Performance & Plans	5 Year Performance & Plans	10 Year Performance & Plans
<b>Multiple Categories</b>				
50% Scope 1 & 2 GHG emissions reduction by FY 2025 from a FY 2008 baseline.				
25% Scope 3 GHG emissions reduction by FY 2025 from a FY 2008 baseline.				
<b>Energy Management</b>				
25% energy intensity (Btu per gross square foot) reduction in goal-subject buildings by FY 2025 from a FY 2015 baseline.				
EISA Section 432 continuous (4-year cycle) energy and water evaluations.				

Meter all individual buildings for electricity, natural gas, steam and water, where cost-effective and appropriate.				
<b>Water Management</b>				
36% potable water intensity (Gal per gross square foot) reduction by FY 2025 from a FY 2007 baseline.				
30% water consumption (Gal) reduction of industrial, landscaping, and agricultural (ILA) water by FY 2025 from a FY 2010 baseline.				
<b>Waste Management</b>				
Divert at least 50% of non-hazardous solid waste, excluding construction and demolition debris.				
Divert at least 50% of construction and demolition materials and debris.				
<b>Fleet Management</b>				
30% reduction in fleet-wide per-mile GHG emissions reduction by FY 2025 from a FY 2014 baseline.				
20% reduction in annual petroleum consumption by FY 2015 relative to a FY 2005 baseline; maintain 20% reduction thereafter.				
10% increase in annual alternative fuel consumption by FY 2015 relative to a FY 2005 baseline; maintain 10% increase thereafter.				

75% of light duty vehicle acquisitions must consist of alternative fuel vehicles (AFV).				
50% of passenger vehicle acquisitions consist of zero emission or plug-in hybrid electric vehicles by FY 2025.				
<b>Clean &amp; Renewable Energy</b>				
“Clean Energy” requires that the percentage of an agency’s total electric and thermal energy accounted for by renewable and alternative energy shall be not less than 25% by FY 2025 and each year thereafter.				
“Renewable Electric Energy” requires that renewable electric energy account for not less than 30% of a total agency electric consumption by FY 2025 and each year thereafter.				
<b>Sustainable Buildings</b>				
At least 17% (by building count) of existing buildings greater than 5,000 gross square feet to be compliant with the revised Guiding Principles for HPSB by FY 2025, with progress to 100% thereafter.				
Net Zero Buildings: 1% of the site’s existing buildings above 5,000 gross square feet intended to be energy, waste, or water net-zero buildings by FY 2025.				

Net Zero Buildings: All new buildings (>5,000 GSF) entering the planning process designed to achieve energy net-zero beginning in FY 2020.				
Increase regional and local planning coordination and involvement.				
<b>Acquisition &amp; Procurement</b>				
Promote sustainable acquisition and procurement to the maximum extent practicable, ensuring BioPreferred and biobased provisions and clauses are included in 95% of applicable contracts.				
<b>Measures, Funding, &amp; Training</b>				
Annual targets for performance contracting to be implemented in FY 2017 and annually thereafter as part of the planning of section 14 of E.O. 13693.				
<b>Electronic Stewardship</b>				
Purchases – 95% of eligible acquisitions each year are EPEAT-registered products.				
Power management – 100% of eligible PCs, laptops, and monitors have power management enabled.				
Automatic duplexing – 100% of eligible computers and imaging equipment have automatic duplexing enabled.				

<p>End of Life – 100% of used electronics are reused or recycled using environmentally sound disposition options each year.</p>				
<p>Data Center Efficiency. Establish a power usage effectiveness target in the range of 1.2-1.4 for new data centers and less than 1.5 for existing data centers.</p>				
<p><b>Resilience</b></p>				
<p>Discuss overall integration of climate resilience in emergency response, workforce, and operations procedures and protocols.</p>				



## Mission Changes

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While there are no projected changes in mission or program direction over the next five to ten years, there is at least one major initiative that is projected to have a significant impact on sustainability goals. The CEBAF Renovation and Expansion (CRE) project recently reached the CD-1 milestone in FY19 and includes the following scope:

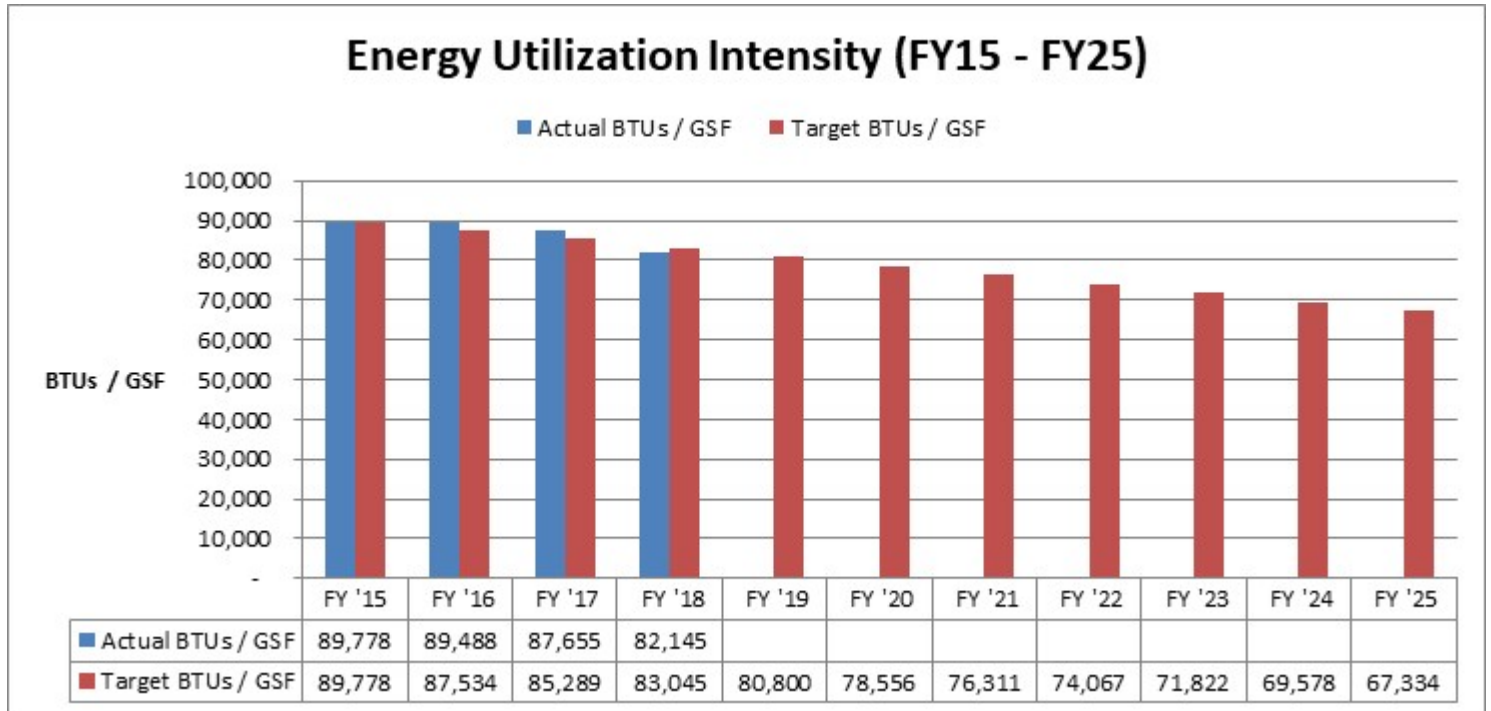
- Elimination of two DOE leased facilities: Support Service Center (34,739 SF) and Facilities Maintenance Shop (2,904 SF)
- Elimination of one contractor leased facility: Applied Research Center (11,097 SF)
- Renovation of the original 1989 portion of CEBAF Center (63,351 SF) and construct a moderate expansion (22,000 SF)
- Acquisition and renovation of the Applied Research Center (121,241 SF)

The design for the renovation and expansion to CEBAF Center as well as the renovation of the ARC building will ensure their compliance in meeting HPSB guiding principles. The CRE CD-4 milestone is projected to be reached by FY26.

# Energy Management

## Performance Status

Jefferson Lab's energy utilization intensity (EUI) new baseline was established in FY15 at 89,778 BTUs/SF (30.1% reduction compared to the previous FY03 baseline of 128,442 BTUs/SF). Jefferson Lab achieved the 30% reduction goal by 2015 defined in Executive Order (EO) 13514. An additional 9% reduction (82,145 BTUs/SF) was achieved from the new FY15 baseline defined in EO 13693. Further reductions in BTUs/SF will occur as identified energy conservation measure (ECM) projects and building renovations are implemented which will enable Jefferson Lab to achieve the 25% EUI reduction goal by FY25 as indicated in the chart below.



As described in the Executive Summary section of this document, Jefferson Lab completed a major, multi-year consolidation, reconfiguration, and renovation project in FY17 involving two formerly independent data centers. The project included consolidation of an existing tier III data center operating at a PUE of 2.44 and renovation and reconfiguration of an existing tier I data center operating at a PUE of 1.70. This project achieved a Federal Energy and Water Management Award in FY18.



The primary goals identified and achieved for this project, including:

- Implement energy conservation strategies to reduce PUE to 1.4 and enable real-time monitoring of PUE values and trends
- Design a floor plan that accommodates up to 1 MW of computing power to include both high performance computing (HPC) and core computing systems
- Create an isolated space dedicated to core computing with the capability to implement tier III cooling and electrical systems
- Ensure construction is phased such that the data center remains fully operational for the duration of the project

Multiple energy conservation strategies were implemented to achieve PUE reduction including:

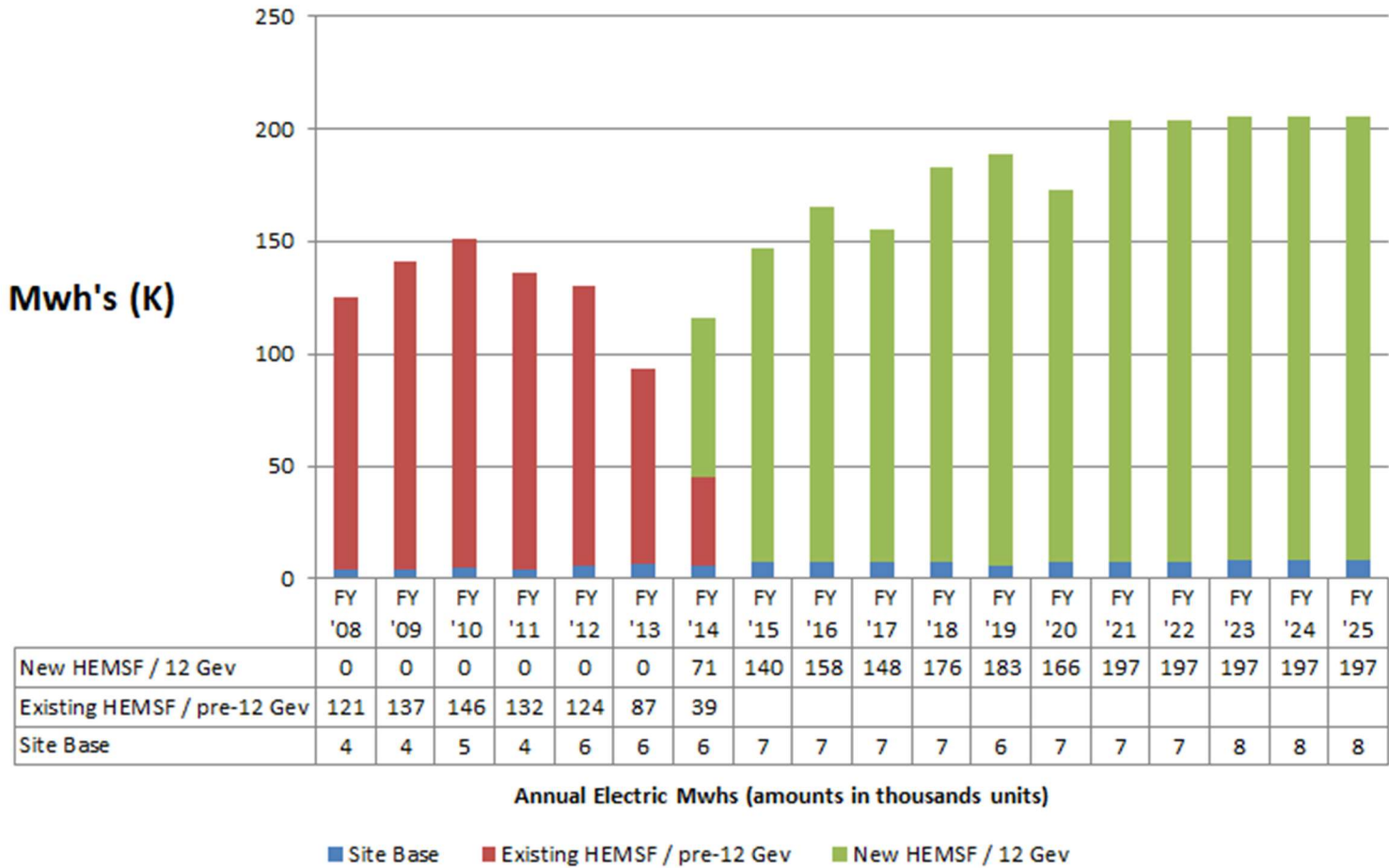
- Hot aisle containment
- Highly efficient upgraded computer room air handling units
- Increased data center supply temperature and improved humidity control
- Efficient uninterrupted power supplies
- Real-time monitoring and continuous calculation of the data center PUE integrated with existing building management systems

Results of this successful project provide the following:

- Information technology (IT) expansion capability for the next 10 years
- Significant energy and water consumption reduction (elimination of a cooling tower dedicated to one of the former data centers)
- Average PUE of approximately 1.3, which is significantly below the 1.5 PUE target goal for existing data centers

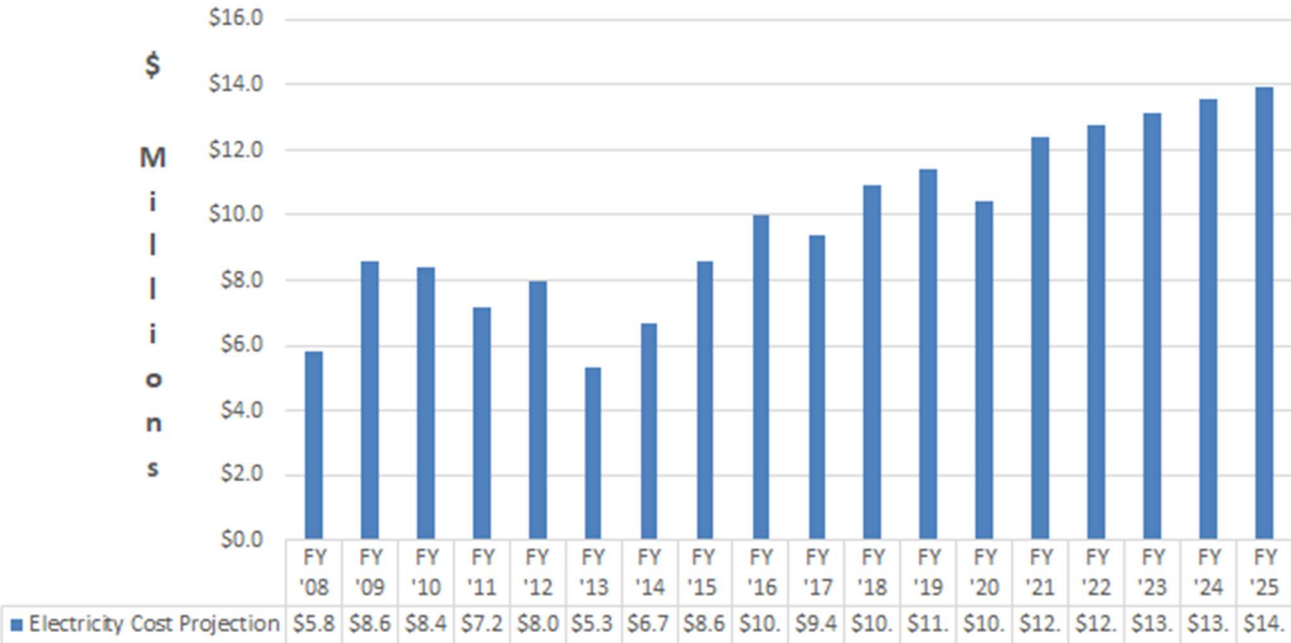
The following graph shows historic actual and projected EUI through FY25 for HEMS and site base facilities:

### Chart 1 / Electricity Projections for TJNAF HEMSF



The following graph indicates historic actual and projected electricity costs through FY25:

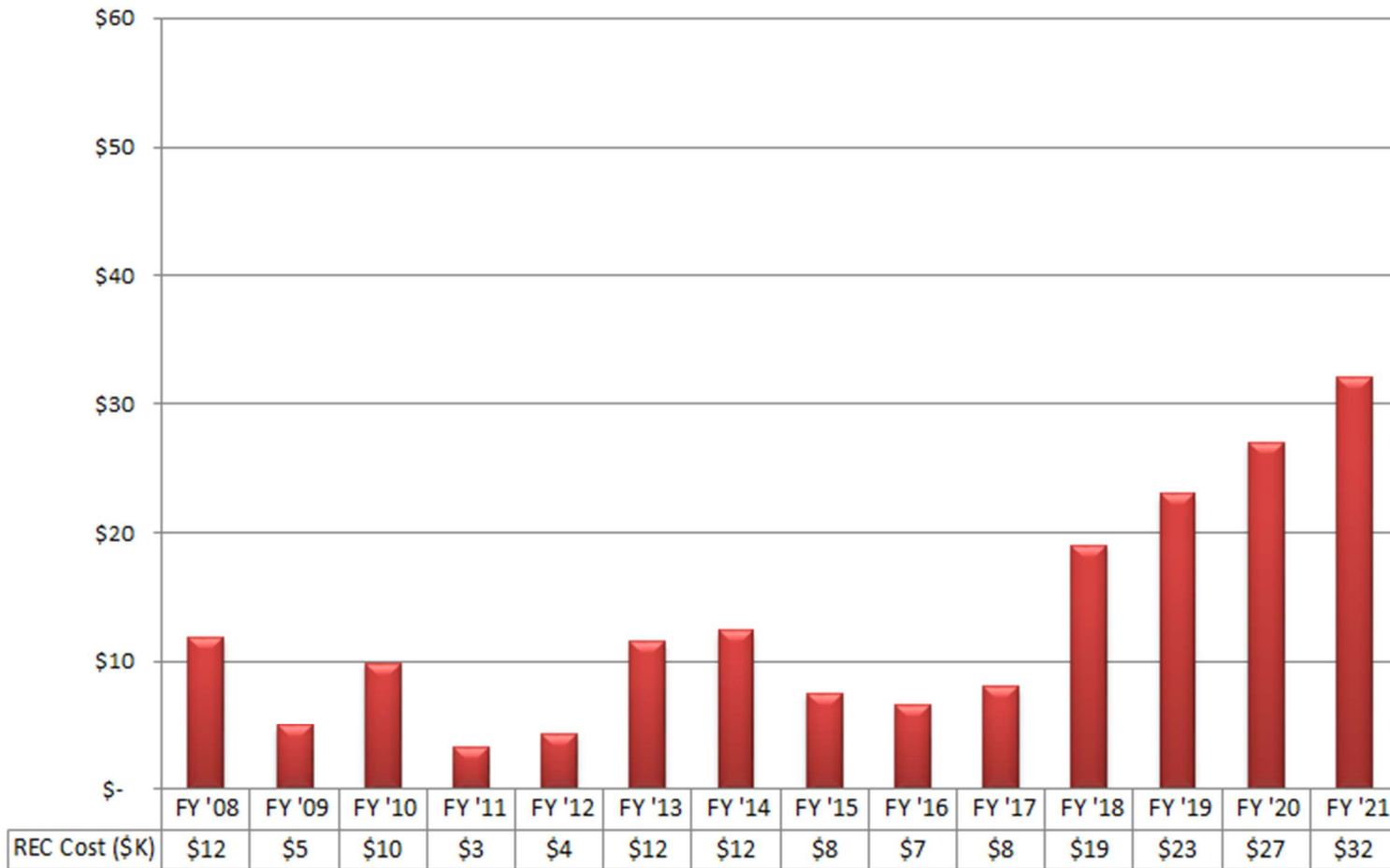
Chart 2/ Electricity Cost Projection



The following graph indicates renewable energy credit (REC) costs through FY25:

### Chart 3 / REC Cost Projection

■ REC Cost (\$K)



REC Cost Amounts in Thousands

#### Plans and Projected Performance

Jefferson Lab plans to implement ECM projects in existing goal subject buildings that will significantly reduce EUI to achieve the 25% reduction goal. These projects include:

- Interior and exterior LED lighting upgrades
- Advanced lighting controls
- Chilled water distribution efficiency improvements



# Water Management

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## Performance Status

Approximately 66 million gallons of potable water (84% of Jefferson Lab's total potable water consumption in FY19) was required for evaporative cooling of High Energy Mission Specific Facilities (HEMSF). FY19 potable water intensity increased by approximately 30% from the FY07 baseline, due primarily to increased overall accelerator operations. Consequently, achievement of the water intensity goal remains the most significant challenge for Jefferson Lab.

Multiple water reduction and alternative water source strategies (including rainwater harvesting) have been evaluated during the past several years. One identified strategy was successfully completed in FY19. The project uses ultra-pure water (UPW) which is currently discharged from the Test Lab facility to sanitation and diverts this to a nearby cooling tower for use as a make-up water supply source. Estimated annual potable water reduction from this project is approximately 5 million gallons of annual consumption.





### **Plans and Projected Performance**

As potable water consumption from evaporative cooling is anticipated to increase significantly in future years as the scientific mission increases, additional sources of alternative water supply will be required to achieve a 36% reduction in water intensity compared to the FY07 baseline level. A potential source of alternative (non-potable) water involves a rainwater harvesting project with the City of Newport News, VA. This project is estimated to provide 40+ million gallons of annual supply which would achieve the water intensity reduction goal by FY25.

The following chart lists the four HEMSF buildings and their related cooling tower and industrial water use which consume the highest gallons/GSF of all buildings at Jefferson Lab (73% of all potable water consumed in FY19):

North Access	15,041,120	8,332	1,805.22
South Access	9,843,510	8,332	1,181.41
Central Helium Liquefier	21,269,950	22,038	965.15
Test Lab	11,099,590	142,010	78.16

# Waste Management

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

# Fleet Management

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

# Clean & Renewable Energy

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

# Sustainable Buildings

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## Performance Status

Current compliance with High Performance Sustainable Building (HPSB) Guiding Principles (24.9% of GSF) exceeds the 2025 compliance goal (17% of GSF).

In FY12, Jefferson Lab completed the Technology and Engineering Development (TED) Building, its first High Performance Sustainable Building complying with the Guiding Principles.



This new, 74,000 GSF office, laboratory, and high bay facility earned LEED Gold certification and includes many energy, water efficiency, and other sustainable features including:

- Geothermal heat pump system provides 80% of HVAC requirements
- Grey water reuse system delivers 100% of sanitation water
- Solar thermal/domestic water heating system
- 44% potable water reduction/low flow plumbing fixtures

In FY13, Jefferson Lab completed its second new construction/major renovation project designed to achieve LEED Gold certification. The project included renovation of 95,000 GSF of office, laboratory, and high bay space in the Test Lab facility as well as a 43,600 GSF laboratory addition. The Test Lab earned LEED Gold certification in FY14 and therefore complies with HPSB Guiding Principles.



### **Plans and Projected Performance**

In FY17, construction of a new office and laboratory facility (Environmental, Safety, Health & Quality Building) was completed and occupied. This 12,000 GSF building was designed to comply with all HPSB guiding principles. Energy and water efficient sustainable features include LED lighting, solar tube daylight harvesting, and a highly efficient variable refrigerant flow (VRF) system for heating and cooling. This building was designed and constructed to consume 35.4% less energy than the ASHRAE 90.1 - 2007 baseline which exceeds the HPSB requirements of 30%. The building is scheduled for benchmarking in Portfolio Manager in FY20.



Future new construction projects (Test Lab High Bay Annex) and major renovation/addition projects (Building 89, CEBAF Center, and Experimental Equipment Lab) will be designed to achieve compliance with HPSB Guiding Principles. As these projects are completed, each affected facility will be benchmarked in Portfolio Manager to ensure compliance.

# Acquisition & Procurement

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.



# Measures, Funding, & Training

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

The following table indicates sustainability funding through FY21:

Sustainability Projects	153,331	321,229	0
Sustainability Activities other than projects	0	0	0
SPO Funded Projects (SPO funding portion only)	0	43,600	0
Site Contribution to SPO Funded Project	0	195,400	0
ESPC/UESC Contract Payments (if applicable)	0	0	0
Renewable Energy Credits (REC) Purchase Costs (if applicable)	23,400	27,018	32,319

# Travel & Commute

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

In April 2019, Jefferson Lab launched the Alternate Work Schedule (AWS)/Flex program; a new employee incentive designed to support a healthy work/life balance at the lab. Efforts will be made during FY20 to quantify the impact of this program on travel and commute sustainability goals.

# **Fugitives & Refrigerants**

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## **Performance Status**

The performance of the site for this category is consistent with prior year.

## **Plans and Projected Performance**

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

# Electronic Stewardship

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## Performance Status

The performance of the site for this category is consistent with prior year.

## Plans and Projected Performance

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

# Resilience

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## **Performance Status**

The performance of the site for this category is consistent with prior year.

## **Plans and Projected Performance**

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

## SC Supplemental Guidance

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### **Performance Status**

The performance of the site for this category is consistent with prior year.

### **Plans and Projected Performance**

Jefferson Lab has achieved interim goals in this category and plans to continue similar practices to achieve results that meet or exceed requirements of this goal category.

## **Appendix - List of Uploaded Documents**

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