# NASA Langley Research Center

# Environmental Management and Sustainability Plan

# 2016 Update

**January 29, 2016**

**NASA LaRC 2016 Environmental Management and Sustainability Plan**
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## Introduction

### Sustainability Policy

The National Aeronautics and Space Administration (NASA) publishes its Strategic Sustainability Performance Plan (SSPP) annually to document the Agency's sustainability policy, overarching strategy, and framework for achieving the long-term sustainability goals contained in existing statutory requirements and Executive Orders.

**NASA's sustainability policy is:**

To execute NASA's mission without compromising our planet's resources so that future generations can meet their needs. Sustainability involves taking action now to enable a future where the environment and living conditions are protected and enhanced. In implementing sustainability practices, NASA manages risks to mission, risks to the environment, and risks to our communities. To this end, NASA seeks to be practical in the integration of sustainability and sustainable practices by leveraging existing management systems, decision-making, and processes. This includes encouraging employees to apply sustainability to all aspects of their daily work, using public funds efficiently and effectively, promoting the health of the planet, and operating in a way that benefits our neighbors.

In March 2015, Executive Order (EO) 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* and EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, which established sustainability goals for the federal government, were superseded by EO 13693, *Planning for Federal Sustainability in the Next Decade*. However, the subject of many of the goals set in the previous EOs were carried over into the new EO. In Fiscal Year (FY) 2015, NASA extended its commitment to sustainability under EO 13693. In accordance with templates and guidance provided by the Council on Environmental Quality (CEQ) and the Office of Management and Budget (OMB), the NASA SSPP addresses final progress towards the goals previously established in EO 13423 and EO 13514, as well as strategies to meet the new goals of EO 13693. In executing its mission, the NASA Langley Research Center (LaRC) has adopted the Agency sustainability policy and NASA sustainability goals from the 2015 SSPP.

**LaRC's Environmental Management and Sustainability Plan** (EMSP) serves as the Center's documentation of progress toward all goals outlined in the NASA SSPP. The Center Sustainability Officer (CSO) oversees the plan's implementation. This position is currently held by the director of the Center Operations Directorate (COD). The primary responsibility for LaRC's environmental compliance, management, and sustainability efforts lies within the COD in the Standard Practice and Environmental Engineering Branch (SPEEB).

The EMSP provides a concise record of LaRC's commitment to, and contributions toward, the goals and requirements of the NASA SSPP, as well as documentation of potential program improvements. The sections of this plan correspond to the SSPP goals, which LaRC has adopted as its own EMSP goals. LaRC's EMSP also adopts the overall template and layout of the NASA SSPP.

A review of past performance is useful to determine program effectiveness, as well as development of strategies for future implementation. Procedures and progress formulated while working towards completing the objectives of EO 13423 and 13514 provide the framework necessary to meet the objectives of future EOs, such as EO 13693. Table 1 below provides a summary of the goals established under EO 13423 and 13514 and a visual status indicator (stoplight) of LaRC's progress towards those goals. The status indicator identifies if the goal was met (green), not met but a plan was in place for improvement (yellow), or not met and no plan was anticipated (red). If an EMSP goal consisted of more than one individual target, then the status of each target is indicated in the appropriate section of the plan.

The statuses reported in chapters 1 through 10 do not address all new goals prescribed by EO13693, as some require new baseline year data and end goal targets. LaRC's implementation methods and planning actions for the new EO 13693 goals are described in Chapter 11.

The EMSP chapters are comprised of the following subsections:

**Chapters 1 through 10 (Previous EO Goals)**

- **Goal Description** – provides the applicable goals and requirements quoted directly from the 2015 SSPP.
- **Center Status** – provides a status update on LaRC's progress in meeting Agency and Center goals and objectives in each resource area.
- **Highlights** – provides a description of LaRC's recent achievements and successes in each resource area.

**Chapter 11 (EO 13693 Goals)**

- **Goal Description** – provides the applicable goals and requirements quoted directly from the 2015 SSPP.
- **Implementation Methods** – identifies ongoing and planned projects, methods, and strategies in managing each resource area. Relevant historical data is also provided as necessary.
- **Opportunities for Program Improvement** – identifies projects, activities, management approaches, and other ideas for program improvement.

**Table 1 – Goal Summary**

| GOAL SUMMARY (EO 13423 and EO 13514) | | |
|---|---|---|
| | Goal 1: Greenhouse Gases (GHG)<br>Reduce direct GHG emissions (onsite or offsite) by 18.3% and indirect emissions (e.g., commuting, travel) by 12.3% by FY 2020, compared to 2008. | |
| | Goal 2: Sustainable Buildings<br>*Facility Energy Intensity:* Reduce energy consumption/gross square foot (GSF) of building area by 3% annually from FY 2003 baseline for FY 2006 – FY 2015 (30% total reduction).<br>*Sustainable Buildings:* At least 15% of Agency's existing buildings meet Guiding Principles by FY 2015. | |
| | Goal 3: Fleet Management<br>Reduce petroleum use by 2% annually, compared to 2005.<br>Increase use of alternative fuels by 10% annually through FY 2015. | |
| | Goal 4: Water Use Efficiency and Management<br>Reduce potable intensity (gallons/square foot) by 2% annually from FY 2007 baseline for FY 2008 – FY 2020 (26% total reduction).<br>Reduce use for industrial, landscaping, & agricultural by 2% annually, compared to FY 2010. | |
| | Goal 5: Pollution Prevention and Waste Reduction<br>Divert 50% of solid waste (excluding construction and demolition debris).<br>Divert 50% of construction and demolition debris. | |
| ENERGY STAR | Goal 6: Sustainable Acquisition<br>>95% of applicable new contract actions meet federal mandates for acquiring products that are energy efficient, water efficient, biobased, environmentally preferable, non-ozone depleting, recycled content, or are non-toxic or less toxic alternatives. | |
| | Goal 7: Electronic Stewardship and Data Centers<br>Procure energy-efficient equipment rated per Electronic Product Environmental Assessment Tool (EPEAT).<br>Use best practices for computer operation and disposal. | |
| | Goal 8: Renewable Energy<br>For FY 2013 and beyond, 7.5% of agency's total electricity consumption is from renewable energy sources. | |
| | Goal 9: Climate Change Resilience<br>Evaluate climate change risks to identify and manage the effects of climate change on the agency's operations and mission in both the short and long term. | |
| | Goal 10: Energy Performance Contracts<br>For NASA, award $73.9M in Energy Savings Performance/Utility Energy Service Contracts by the end of 2016. | |

# 1 Goal 1: Greenhouse Gases (GHG)

## 1.1 Goal Description (Agency Goal)

**Reduce direct GHG emissions (onsite or offsite) by 18.3% and indirect emissions (e.g., commuting, travel) by 12.3% by FY 2020, compared to 2008.**

## 1.2 Center Status

**Reduce direct GHG emissions (onsite or offsite) by 18.3% by FY 2020**

As described in the Agency SSPP, NASA Headquarters (HQ) established a Scope 1 and 2 GHG emissions reduction target of 18.3% by FY 2020, from a FY 2008 baseline of 1,365,729 metric tons of carbon dioxide equivalent ($MtCO_2e$) across its institutional portfolio. A number of strategies are implemented across the Agency to achieve this goal including: reducing facility energy consumption, increasing use of renewable energy, reducing on-site fossil-fuel consumption by installing more efficient equipment, installing building utility meters to track energy and continuously optimize performance, and ensuring that major renovations and new building designs are 30% more efficient than applicable building code.

As directed by NASA HQ, Centers are not required to determine their individual GHG emissions inventory or to verify the Agency calculations. NASA HQ has that responsibility as the Portal reporting tool utilizes Agency-wide data (primarily energy reporting) to automatically calculate and report the GHG inventory, as required under EO 13514. In addition, there are no Center-specific GHG emission reduction targets, only the NASA-wide targets required in the EO. Therefore, LaRC receives a “green” rating for this goal.

A significant portion of the Center’s steam requirements are met by the NASA-City of Hampton Waste to Energy Steam Plant where trash from the Center and surrounding localities is diverted from the landfill and utilized as fuel for steam production. This reduces the need for fossil fuels for steam generation and reduces GHG emissions. One significant challenge to GHG emission goals in FY 2015 was the failure of the Tunnel 4 steam line which supplies steam from the Waste to Energy Plant to the Center. Repairs were initiated in FY 2015 and should be completed in FY 2016, allowing steam to once again be supplied by this renewable resource.

**Reduce indirect emissions (e.g., commuting, travel) by 12.3% by FY 2020**

As described in the Agency SSPP, NASA HQ established a Scope 3 GHG emissions reduction target of 12.3% by FY 2020, from a FY 2008 baseline of 171,277 $MtCO_2e$ across its institutional portfolio. As with Scopes 1 and 2, energy use reduction efforts help reduce Scope 3 GHG emissions. In addition, other strategies are implemented across the Agency, such as increasing employee use of teleworking, continuing efforts to reduce employee business travel, identifying opportunities to reduce commuter emissions, and promoting a bicycle commuting infrastructure.

As directed by NASA HQ, Centers are not required to determine their individual GHG emissions inventory or to verify the Agency calculations. NASA HQ has that responsibility as the Portal reporting tool utilizes Agency-wide data to automatically calculate and report the GHG inventory, as required under the EO. In addition, there are no Center-specific Scope 3 GHG emission reduction targets, only the NASA-wide targets required in EO 13514. Therefore, LaRC receives a “green” rating for this goal.

### 1.3 Highlights

In 2015, LaRC completed the following projects at the Center:

- The Building 1215 Steam Plant continues to use a new high-efficiency Cleaver-Brooks/Nebraska boiler that was put into service in January 2014. This new boiler replaced an older, less efficient unit. It is expected that on-site fossil fuel consumption will continue to be reduced as a result of operating this high-efficiency boiler.

- A new, replacement heat exchanger for the R-134a (a greenhouse gas) reclaim system at the LaRC Transonic Dynamics Tunnel (TDT) was installed in May of 2015. Installation of the new heat exchanger restored operating efficiency of the R-134a reclaim system and minimized losses of R-134a to the atmosphere during tunnel operation in heavy-gas mode. GHG emissions were reduced.

- Also, see Section 2 (Sustainable Buildings), Section 3 (Fleet Management), and Section 8 (Renewable Energy) of this Plan for details on other activities and projects that contributed to GHG emission reductions.

# 2 Goal 2: Sustainable Buildings

## 2.1 Goal Description

***Facility Energy Use Intensity*: Reduce energy consumption/GSF of building area by 3% annually from FY 2003 baseline for FY 2006 – FY 2015 (30% total reduction).**

***Sustainable Buildings*: At least 15% of Agency's existing buildings meet Guiding Principles by FY 2015.**

## 2.2 Center Status

### Facility Energy Use Intensity

Energy conservation efforts at Federal facilities are tracked according to the guidelines established in the Energy Policy Act (EPAct) of 2005, which divides Federal facilities into two categories: Goal Subject and Goal Excluded. Many LaRC research facilities, such as wind tunnels, require energy-intensive loads that are driven by mission and operational requirements and are not influenced by conventional building energy conservation measures. These types of facilities are Goal Excluded and not subject to the Federal energy reduction goals. The LaRC Energy Manager has assigned LaRC facilities into their appropriate categories**.**

LaRC's FY 2015 energy usage for all facilities was 901,266 Million BTU (MBTU), an overall usage increase from FY 2014 (830,000 MBTU). However, in FY 2015 the steam line from the Waste to Energy Plant failed, leaving the Building 1215 Steam Plant to generate all steam required for the Center using natural gas fuel. While the Building 1215 Steam Plant is a Goal Excluded facility, this situation resulted in a 252% increase in natural gas usage from 87,476 MBTU in FY 2014 to 308,495 MBTU for all facilities in FY 2015. The steam line for the Waste to Energy Plant is being repaired and should be back on-line in the second quarter of FY 2016.

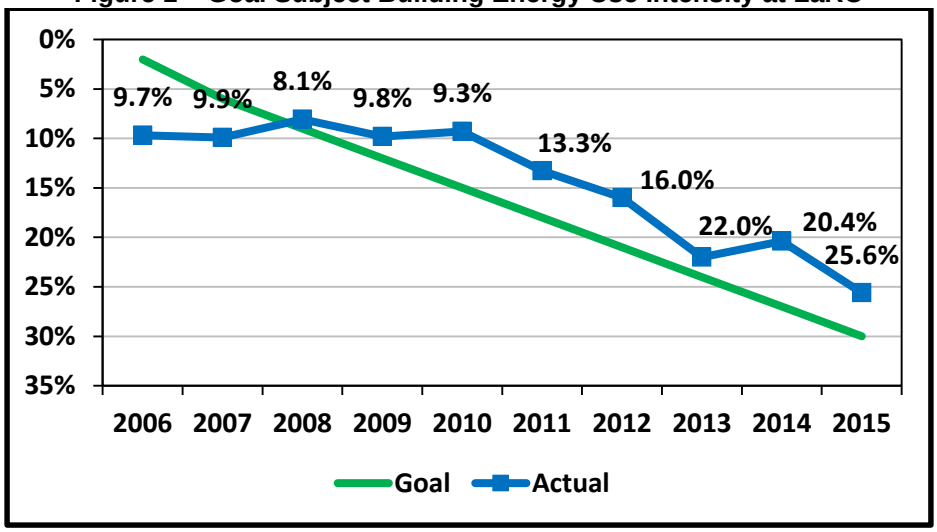
LaRC did report Goal Subject energy intensity reductions of 25.6% below the FY 2003 baseline for FY 2015 (see Figure 1). Though less than the required 30%, colder winter temperatures in FY 2015 and not being able to utilize weather normalization for the goal were strong factors influencing the Center missing the mark on Goal Subject energy intensity reduction. Moving forward, EO 13693 sets a FY 2015 baseline and allows for weather normalization of data so that true goal progress in energy intensity reduction can be measured.

### Sustainable Buildings

In order to meet the requirement that 15% of NASA's existing capital asset building inventory incorporates the Guiding Principles for Sustainable Existing Buildings by the end of FY 2015, NASA HQ requested that LaRC ensure a minimum of four buildings totaling 135,180 GSF meet the Guiding Principles. The Center's new Headquarters Building and the new Integrated Engineering Services Building (IESB), along with Buildings 1231C and 1245, demonstrated the performance necessary to meet the Guiding Principles goal by the end of FY 2015.

LaRC has met the quantitative metrics outlined in the Executive Orders, including the requirement that 15% of the Center's existing buildings meet the Guiding Principles by the end of FY 2015 ("15x15") and that all new construction and major rehabilitation/renovations meet the Guiding Principles.

**Figure 1 – Goal Subject Building Energy Use Intensity at LaRC**




## 2.3 Highlights

<u>Facility Energy Use Intensity:</u>

In FY 2015, LaRC initiated and/or completed the following energy conservation program projects at the Center:

- LaRC is performing a $173K steam system study to assess current/projected steam requirements through 2030 and evaluate alternatives for meeting demand. The study also assessed the feasibility of combined heat and power energy production in each of the Center's two steam plants. The study includes (1) projected steam requirements, (2) Waste to Energy Plant capacity, cost, efficiency, and reliability, (3) Building 1215 capacity, cost, efficiency and reliability, (4) costs and benefits of having dual steam plants with three different fuel capabilities, and (5) the feasibility of modifying the Waste to Energy Plant to efficiently utilize excess steam. The study is still in progress with an anticipated completion date of March 31, 2016.

- Continued retro-commissioning of Goal Subject buildings, including heating, ventilation, and air conditioning (HVAC) systems and controls, distribution systems, supplemental loads, and lighting.

- Continued with the Agency-funded $1.68M Energy Efficiency Improvements Project (Retro-commissioning of 16 buildings, Lighting Retrofits in Building 1195 Complex). Project completion is expected in June 2016. One building was added to the retro-commissioning in FY 2015.

- Energy Advisor Software Pilot: 10-building pilot program for software testing that will allow real-time energy analytics and management.

- Advanced Steam Metering: The Energy Independence and Security Act (EISA) 2007 requires advanced steam metering in all appropriate Federal buildings by the end of FY 2016. Advanced steam meters will allow the Center to provide programs with accurate utility data to encourage operators to take ownership of reducing costs to mission through efficiency improvements. Installation of 46 meters is expected to be complete by the end of FY 2016.

- Installation of upgrade to Struxureware Power Monitoring Expert 8.0 software for building level monitoring of energy consumption. Energy Program and Utility Program staff attended a 2-day training on the use of Struxureware for Power Monitoring in April 2015.

- Center-Funded Small Energy Projects: 17 small energy projects recommended by personnel across the Center, including lighting and building envelope projects, were funded and completed in FY 2015 at a total cost of $179K. Approximately 52 projects with $399K in funding were completed for the period of FY 2012-FY 2015.

- Ongoing assessments of HVAC run schedules to determine adjustments for reduction in energy consumption.

- Completion of 36 facility energy and water audits. Audits included comprehensive audits completed as part of a retro-commissioning project of LaRC's "15x15" buildings, as well as walkthrough audits completed by LaRC energy management personnel.

- 2nd Annual Energy Star certification for Building 2101 in FY 2015. This is LaRC's first Energy Star certified building.

Training and outreach continued to be a core component of energy management at LaRC in 2015, including the following activities:

- LaRC Energy Program staff trained Facility Coordinators (FCs) and Facility Environmental Coordinators (FECs) in facility energy management through SPEEB's annual FEC training, Safety and Health Awareness Month training, and quarterly FC/FSH (Facility Safety Head) meetings. In addition, energy and water conservation training opportunities were held during Energy Action Month in October 2015. A total of 14 energy and water management training opportunities (including tours) were held in FY 2015 and attended by 279 employees.

- In October 2015 LaRC Energy Program staff held a successful Energy Action Month, which included: LaRC personnel tours of the Waste to Energy Plant and Newport News Waterworks regional water treatment facility; a Home Energy and Water Expo featuring the region's utility providers and energy and water environmental outreach displays; and training opportunities in home energy auditing, Agency net zero energy goals, and power monitoring of buildings for facility personnel.

- The LaRC Energy Manager and Energy Analyst attended the Annual Department of Energy (DOE) Energy Exchange conference in Phoenix, AZ in August 2015.

- The LaRC Energy Manager and Energy Analyst attended a face-to-face meeting of the NASA Energy Efficiency Panel, the community of practice for NASA Center Energy Managers across the Agency.

- The LaRC Energy Analyst attended the World Energy Engineering Congress in September 2015, with numerous training opportunities attended, including energy management, energy auditing, and interval meter data analysis.

- LaRC's Energy Manager, Utility Manager, and facilities staff attended a 2-day training in Struxureware Power Monitoring software.

<u>Sustainable Buildings:</u>

The following initiatives highlight LaRC's progress toward Sustainable Building objectives:

- LaRC continued implementing its comprehensive 20-year revitalization program called ViTAL (Vibrant Transformation to Advance LaRC) which includes constructing new state-of-the-art facilities, renovating and upgrading critical infrastructure, and demolishing non-essential assets. This 20-year effort is intended to modernize the center core of LaRC, better align LaRC's facilities with its future mission requirements, and significantly reduce the Center's infrastructure and

operations and maintenance costs. All of the new buildings and major renovations will meet Leadership in Energy and Environmental Design (LEED) Silver requirements at minimum.

- A new central data center, designated the Computational Research Facility (CRF), began construction in FY 2015 and is expected to be completed in FY 2016. This project will achieve a minimum LEED-NC Silver certification.

- In FY 2015 and FY 2016, retro-commissioning is being performed on Buildings 645, 645A, 1189, 1199, 1202, 1202A, 1209, 1220, 1244, 1244C, 1244D, 1268A, 1293A, 1293B, 1299, and 1299F. Systems included in the retro-commissioning process are the HVAC systems and controls, distribution systems, supplemental loads, and lighting. The objectives of the project include: confirming and documenting existing building and equipment operating conditions; analyzing current building equipment performance; making recommendations for improvements to systems or equipment that will increase building operating efficiency and reduce energy costs; and providing consistent operating documentation for building operations and maintenance staff.

- In 2015, LaRC COD engineering and environmental personnel continued development and revision of facility construction specifications and facility design standards to ensure sustainable design and construction principles become standardized in Center projects.

- The LaRC environmental personnel continued to make progress in ensuring that the Langley Form 461, Environmental Project Planning Form, is submitted for all applicable projects to ensure environmental impacts are reviewed and various environmental requirements are met. The environmental review incorporates most of the goals covered in this section.

# 3 Goal 3: Fleet Management

## 3.1 Goal Description

**Reduce petroleum use by 2% annually, compared to 2005.**

**Increase use of alternative fuels by 10% annually through FY 2015.**

## 3.2 Center Status

**Reduce Petroleum Use in Fleet Vehicles**

NASA LaRC is exceeding the petroleum reduction goal and has achieved a 57% reduction in fleet vehicle fuel use compared to the FY 2005 baseline. Table 2 shows the LaRC fleet vehicle fuel consumption data from FY 2005 to present.

**Table 2 – LaRC Fleet Vehicle Fuel Consumption**

**Fuel Consumption (in units of Gasoline Gallon Equivalents (GGE))**

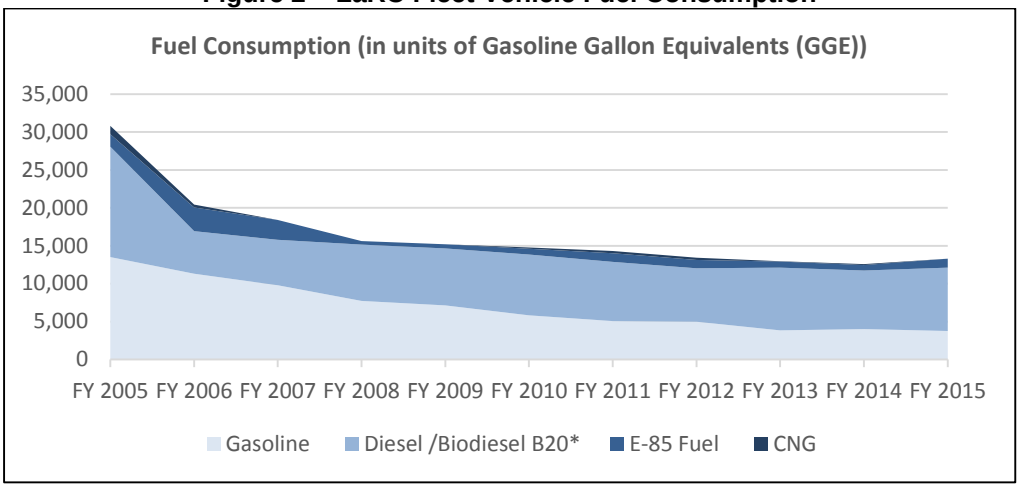
| | *Gasoline* | *Diesel / Biodiesel B20** | *E-85 Fuel* | *Compressed Natural Gas (CNG)* | Total |
|---|---|---|---|---|---|
| FY 2005 | 13,519 | 14,561 | 1,658 | 1,104 | 30,842 |
| FY 2006 | 11,294 | 5,651 | 3,103 | 387 | 20,435 |
| FY 2007 | 9,793 | 6,016 | 2,605 | 0 | 18,414 |
| FY 2008 | 7,739 | 7,397 | 496 | 2 | 15,634 |
| FY 2009 | 7,119 | 7,548 | 511 | 0 | 15,178 |
| FY 2010 | 5,818 | 8,010 | 796 | 145 | 14,769 |
| FY 2011 | 5,050 | 7,836 | 1,118 | 294 | 14,298 |
| FY 2012 | 4,994 | 7,020 | 1,122 | 285 | 13,421 |
| FY 2013 | 3,855 | 8,254 | 816 | 25 | 12,950 |
| FY 2014 | 4,020 | 7,720 | 719 | 109 | 12,568 |
| FY 2015 | 3,767 | 8,329 | 1,222 | 0 | 13,318 |

Source: FAST data provided by Logistics Management Branch
*Note - LaRC used B20 Biodiesel Fuel from May 2002 – November 2009

**Increase Use of Alternative Fuels**

Because of LaRC's steady decrease in overall fuel consumption, LaRC did not meet the goal of increasing alternative fuel use by 10% annually from a FY 2005 baseline for FY 2005 – FY 2015. Figure 2 shows the decline in fuel usage of all types, including alternative fuels. Currently, LaRC has 25 E-85 vehicles.

**Figure 2 – LaRC Fleet Vehicle Fuel Consumption**




*Note - LaRC used B20 Biodiesel Fuel from May 2002 – November 2009

### 3.3 Highlights

At the Agency level, NASA is currently exceeding both vehicle fleet management goals. Several actions were implemented at LaRC in 2015 that support achievement of Agency goals including:

- Four low speed electric vehicles (LSEVs) were acquired from NASA's White Sands Test Facility. The vehicles were used in a pilot program to evaluate their feasibility at LaRC. The vehicles were delivered to LaRC in April 2015.

- From April through the end of September 2015, the LSEVs were driven 949 miles, and consumed 158 kilowatts of electricity at a cost of $10.27.

- Six new and seven used flexible fuel light duty (pickup) trucks were acquired, and 13 old gasoline fueled light duty trucks were excessed.

- New vehicles acquired in 2015 also included one additional bus, one new Americans with Disabilities Act (ADA) compliant van, and one box truck.

- Continued use of the Center-owned bicycles contributed to a reduction in petroleum consumption. This green initiative also doubles as a cost savings initiative. Use of the bicycles reduces motor vehicle usage on Center, which reduces fuel consumption, emissions, and traffic.

- In FY 2015, a strategic and cost decision was made to eliminate CNG vehicles and to focus on use of LSEV and flexible fuel vehicles for the LaRC fleet.

# 4 Goal 4: Water Use Efficiency and Management

## 4.1 Goal Description

**Reduce potable intensity (gallons/square foot) by 2% annually from FY 2007 baseline for FY 2008 – FY 2020 (26% total reduction).**

**Reduce use for industrial, landscaping, and agricultural by 2% each year, compared to FY 2010.**

## 4.2 Center Status

**Reduce Potable Water Use Intensity**

The data in Figure 3 and Table 3 show LaRC's progress towards achieving the goal of reducing water consumption intensity. In FY 2015, LaRC's water consumption intensity had been reduced by 22.7% relative to the FY 2007 baseline, elevated some from FY 2014, but still on track for meeting the FY 2020 goal based on annual consumption. This positive trend is a result of less water usage for demolition and construction activities on Center, fewer water system leaks, and fewer operational issues on cooling towers. The Center continues to aggressively pursue ways to identify leaks and operational problems more quickly. In addition, water conservation projects will continue to be implemented in support of reducing water consumption intensity.

**Figure 3 - Water Use Intensity Reduction at LaRC**

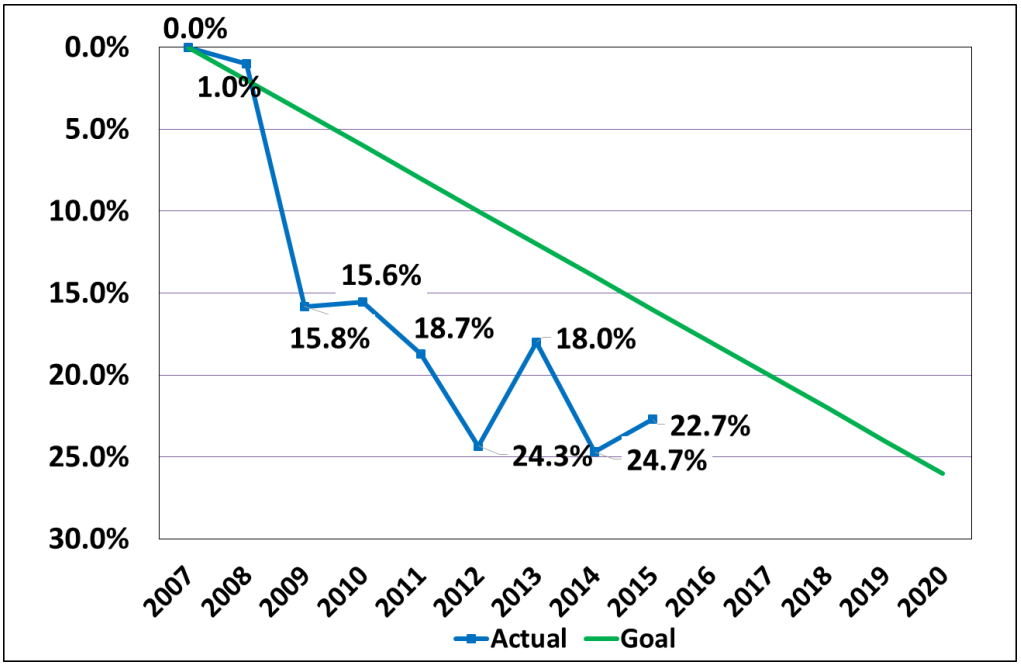


**Table 3 - Water Use Intensity at LaRC (Gal/GSF)**

| Year | Goal | Actual | Goal Attained |
|---|---|---|---|
| Baseline Year (FY 2007) | N/A | 45.8 | -- |
| FY 2008 | 44.9 | 45.4 | Yes |
| FY 2009 | 44.0 | 38.6 | Yes |
| FY 2010 | 43.1 | 39.3 | Yes |
| FY 2011 | 42.2 | 37.3 | Yes |
| FY 2012 | 41.3 | 34.7 | Yes |
| FY 2103 | 40.3 | 37.6 | Yes |
| FY 2014 | 39.4 | 34.5 | Yes |
| FY 2015 | 38.6 | 35.5 | Yes |

The Center is on track to meet the FY 2020 goal; however, EO 13693 continues the water intensity reduction goal of 2% annually through FY 2025 for a total 36% reduction in water intensity relative to the FY 2007 baseline. While center operations improvements, conservation, and leak detection help to reduce water intensity on Center, LaRC's aggressive demolition plan may prevent the Center from meeting the FY 2025 reduction goals. Planned demolition projects could inadvertently cause an increase in water use intensity. Even though square footage for the Center will be reduced, total water consumption is not projected to drop significantly, since there is not a concurrent reduction in personnel and research operations. In addition, water for steam will not decrease accordingly (the Waste to Energy Plant water consumption will stay at current rates as long as the facility is operating at current capacity, a factor independent of LaRC activity). Therefore, water consumption will remain fairly constant even as square footage drops, driving up the use intensity ratio. Seeing as demolition impacts may hinder LaRC in meeting the FY 2025 goal of 36% reduction in water consumption intensity relative to the FY 2007 baseline, additional investment in projects to reduce water consumption will likely be required to ensure LaRC meets this goal.

**Reduce Industrial, Landscaping, and Agricultural Water Use**

LaRC does not use potable water for agricultural or landscaping purposes, except to establish new landscape plants. Water that is used for industrial and limited landscaping use is included in the Center-wide water reduction goal. Since LaRC is exceeding the goal of reducing water consumption intensity, the Center is considered meeting the goal to reduce industrial, landscaping, and agricultural water use.

### 4.3 Highlights

In FY 2015, LaRC completed the following projects impacting water consumption at the Center:

- Upgrades to HVAC equipment in three buildings. Improvements to HVAC systems generally resulted in decreased water usage.
- Replacement of HVAC equipment in various buildings.
- Ongoing assessments of HVAC run schedules to minimize energy and water consumption.
- Retro-commissioning of 17 buildings, including HVAC systems and controls, distribution systems, supplemental loads, and lighting.
- Repairs and energy conservation measures identified in the retro-commissioning project.
- Completion of 36 facility energy and water audits. These audits included comprehensive audits completed as part of the retro-commissioning project and walkthrough audits completed by LaRC

energy management personnel. This represents approximately 25% of all covered facilities on Center, as Federal installations are required to audit all covered facilities every four years (FY 2015 is the third year of the current four-year cycle).

LaRC initiated or continued the following projects impacting water conservation at the Center:

- Advanced Steam Metering: EISA 2007 requires advanced steam metering in all appropriate Federal buildings by the end of FY 2016. Advanced steam meters will allow the Center to provide programs with accurate utility data to encourage operators to take ownership of reducing costs to mission through efficiency improvements. Installation of 46 meters is expected to be complete by the end of FY 2016.

Training and outreach continued to be a core component of energy and water management at LaRC in FY 2015, including the following activities:

- LaRC Energy Program staff trained Facility Coordinators (FCs) and Facility Environmental Coordinators (FECs) in facility energy management through SPEEB's annual FEC training, Safety and Health Awareness Month training, and quarterly FC/FSH (Facility Safety Head) meetings. In addition, energy and water conservation training opportunities were held during Energy Action Month in October 2015. A total of 14 energy and water management training opportunities (including tours) were held in FY 2015, attended by 279 employees.

- LaRC Energy Program staff addressed water management issues in @LaRC and News@LaRC articles.

- In October 2015, LaRC Energy Program staff held a successful Energy Action Month, which included: LaRC personnel tours of the Waste to Energy Plant and Newport News Waterworks regional water treatment facility; a Home Energy and Water Expo featuring the region's utility providers and energy and water environmental outreach displays; and training opportunities in home energy auditing, Agency net zero energy goals, and power monitoring of buildings for facility personnel.

- The LaRC Energy Manager and Energy Analyst attended the Annual DOE Energy Exchange conference in Phoenix, AZ in August 2015.

- The LaRC Energy Manager and Energy Analyst attended a face-to-face meeting of the NASA Energy Efficiency Panel, the community of practice for NASA Center Energy Managers across the Agency.

- The LaRC Energy Analyst attended the World Energy Engineering Congress in September 2015, with numerous training opportunities attended, including energy management, energy auditing, and interval meter data analysis.

- LaRC Energy Manager, Utility Manager, and facilities staff attended a 2-day training in Struxureware Power Monitoring software.

# 5 Goal 5: Pollution Prevention and Waste Reduction

## 5.1 Goal Description

**Divert 50% of solid waste (excluding construction and demolition debris).**

**Divert 50% of construction and demolition debris.**

## 5.2 Center Status

**Divert at least 50% of non-hazardous solid waste (excluding C&D debris) by the end of FY 2015**

In FY 2015, LaRC landfilled 399,422 pounds and diverted 1,175,222 pounds (includes diverted yard waste, recyclables, and Waste to Energy Plant) of non-hazardous waste. LaRC's diversion rate of 81% significantly exceeds the 50% requirement. Table 4 showcases the diversion data for FY 2015. Table 5 expands on the type of materials recycled in recent years.

**Table 4 - FY 2015 Center Landfill, Waste-to-Energy Steam Plant, and Recycling Data**

| Landfilled (lbs.) | Waste-to-Energy Steam Plant (lbs.) | Recycled (lbs.) | Diverted Yard Debris (lbs.) |
|---|---|---|---|
| 399,422 | 561,873 | 595,615 | 17,734 |

**Table 5 – Recycling of non-hazardous solid waste (excluding C&D debris) (FY 2011-15)**

| Type of Material | FY 2011 (lbs.) | FY 2012 (lbs.) | FY 2013 (lbs.) | FY 2014 (lbs.) | FY 2015 (lbs.) |
|---|---|---|---|---|---|
| Aluminum | 7,580 | 8,230 | 7,540 | 6,780 | 3,260 |
| Batteries | 11,494 | 7,673 | 6,790 | 5,740 | 4,840 |
| Cardboard | 54,060 | 63,860 | 59,980 | 57,040 | 58,540 |
| Copper (incl. copper wire) | 0 | 14,420 | 0 | 0 | 0 |
| Ferrous Metals | 475,556 | 466,208 | 466,052 | 482,837 | 391,225 |
| Fluorescent Lighting Tubes | 14,689 | 2,756 | 2,775 | 2,244 | 1,912 |
| Mixed Paper | 70,520 | 58,300 | 42,140 | 44,120 | 46,300 |
| Toner Cartridges | 2,719 | 2,268 | 1,481 | 1,068 | 1,010 |
| Used Oil | 33,300 | 34,040 | 29,340 | 33,536 | 29,378 |
| White Paper | 109,060 | 82,840 | 59,200 | 57,800 | 52,900 |
| Plastic Bottles | 5,070 | 4,687 | 4,807 | 4,997 | 6,250 |
| Total | 784,048 | 745,282 | 680,105 | 696,162 | 595,615 |

**Divert at least 50% of construction and demolition debris by the end of FY 2015**

In FY 2015, a total of 26,299,512 pounds of C&D debris was generated. Of that amount, 6,019,990 pounds were sent to local landfills, and 20,279,522 pounds were recycled and/or reused. The diversion rate for C&D debris for FY 2015 was 77%. LaRC routinely diverts at least 50% of C&D debris and meets this goal. C&D recycling quantities in recent years are shown in Table 6.

**Table 6 – C&D Debris Recycled at LaRC (FY 2011-15) in pounds**

| Type of Material | FY 2011 | FY 2012 | FY 2013 | FY 2014 | FY 2015 |
|---|---|---|---|---|---|
| Construction and Demolition (C&D) Debris | 20,509,000 | 2,756,600 | 9,528,835 | 21,059,592 | 20,279,522 |

## 5.3 Highlights

The following initiatives highlight LaRC's progress toward these objectives:

- LaRC contracts for construction, demolition, or rehabilitation of facilities require the recycling of debris material to the maximum extent practicable.
- LaRC's Exchange Operations discontinued the use of disposables in the cafeteria's Social Lounge and replaced it with all washable drinkware.

# 6 Goal 6: Sustainable Acquisition

## 6.1 Goal Description

**>95% of applicable new contract actions meet federal mandates for acquiring products that are energy efficient, water efficient, biobased, environmentally preferable, non-ozone depleting, recycled content, or are non-toxic or less toxic alternatives.**

## 6.2 Center Status

To measure progress toward the goal of ensuring 95% of contract actions contain sustainable acquisition and to collect required information for the Agency SSPP submission, the NASA Office of Procurement (OP) requires Contracting Officers (COs) at each center to record sustainable acquisition activity in the Federal Procurement Data System – Next Generation (FPDS-NG). COs are able to select specific sustainability data element choices that are applicable to a procurement. The data elements are based on the sustainable acquisition programs covered in the Federal Acquisition Regulation (FAR) Part 23, as listed below, or a combination thereof:

- Recovered Material Content
- Biobased
- Energy Efficient
- Environmentally Preferable

To monitor performance, Centers perform quarterly reviews of at least 5% of applicable new contract actions to determine if sustainable acquisition requirements are included. LaRC's contract review actions are listed in the table below. LaRC contract specialists provide this data for FPDS-NG and certify that the contract meets the necessary sustainable acquisition requirements.

**Table 7 - LaRC Sustainable Acquisition Contract Review**

| | 1st QTR FY 2015 | 2nd QTR FY 2015 | 3rd QTR FY 2015 | 4th QTR FY 2015 |
|---|---|---|---|---|
| Total # Center Contract Actions | 66 | 87 | 199 | 303 |
| Total # of Actions Reviewed | 10 | 10 | 20 | 23 |
| Total % of Eligible Contract Actions Reviewed | 15% | 11% | 10% | 8% |
| Total # of Compliant Contract Actions | 10 | 10 | 14 | 15 |
| **Total % of Compliant Contract Actions** | **100%** | **100%** | **70%** | **65%** |

LaRC's OP evaluated a total of 63 contract actions in FPDS-NG in FY 2015. Although 100% of the contract actions reviewed were compliant in the first half of FY 2015, several actions reviewed in the last half of FY 2015 were shown to be missing the necessary sustainable acquisition requirements. The majority of LaRC's procurements with sustainable acquisition attributes are Simplified Acquisitions (with a dollar value up to $150K); these Simplified Acquisitions are performed by a support contractor. When it was announced in FY 2015 that LaRC's Simplified Acquisition function would be transferred to the NASA Shared Services Center (NSSC) effective FY 2017, the support contractor lost experienced personnel to other opportunities and hired new employees with little or no green procurement experience. OP will continue to work towards educating its personnel and ensuring that applicable contract actions require the supply or use of sustainable products and services.

NASA HQ also distributes a green purchasing data call annually, and each Center is required to compile information on Center purchases of items designated under the Environmental Protection Agency's (EPA) Comprehensive Procurement Guidelines (CPG) and United States Department of Agriculture's (USDA) BioPreferred Program. This information is then entered into the NASA Environmental Tracking System (NETS). Purchase data for FY 2015 has not yet been calculated, as Centers are not required to submit their information to NASA HQ until the second quarter of FY 2016.

Based on the data received from the FY 2014 data call, LaRC purchasers and applicable contracts reported $283,395 spent on items designated under the EPA's CPG. $269,650 of that was spent on products that contained recovered/recycled content. Purchasers and applicable contracts reported $28,136 spent on products in USDA-designated BioPreferred categories. $19,087 of that was spent on products that contained biobased content.

### 6.3 Highlights

The following initiatives highlight LaRC's progress in the Sustainability Acquisition program:

- SPEEB offered general Sustainable Acquisition training to LaRC personnel during its 2015 Earth Day activities.
- SPEEB Sustainable Acquisition Program leads attended several green purchasing webinars hosted by the General Services Administration (GSA).
- LaRC OP provided information on sustainable acquisition training opportunities to its workforce, including Contracting Officers and Contract Specialists.
- LaRC's center-specific Section H contract clause was identified as a strength during LaRC's 2015 Procurement Management Review (PMR) Overview by NASA HQ. This clause clearly communicates to contractor community the expectation that they must support LaRC in fulfilling its commitment to environmental stewardship.
- LaRC and the Center's construction and maintenance contractor continued the program to replace or retrofit all HVAC equipment that utilizes R-22 refrigerant with SNAP-approved alternatives by 2020.
- LaRC's Exchange Operations continued reduction in Styrofoam use in the new LEED Gold cafeteria.

# 7 Goal 7: Electronic Stewardship and Data Centers

## 7.1 Goal Description

**Procure energy-efficient equipment rated per Electronic Product Environmental Assessment Tool (EPEAT).**

**Use best practices for computer operation and disposal.**

## 7.2 Center Status

Since 2011, HP Enterprise Services manages, secures, and maintains IT infrastructure across all of the Agency's research and flight centers. The program is called Agency Consolidated End-User Services, or ACES. This contract manages approximately 3,400 of the approximately 4,000 computers at LaRC. Other major contracts managing computers include the LaRC Center Maintenance Operations and Engineering (CMOE) and the Langley Information Technology Enhanced Services (LITES) contracts (about 500 machines).

According to LaRC's Office of the Chief Information Officer (OCIO), the ACES contract complies with all EO requirements regarding electronic assets. The ACES contract includes language requiring EPEAT compliance and energy savings, including energy saving equipment and how to handle the final disposition of equipment.

NASA's Data Center Consolidation team determines and implements IT practices that will allow the Agency to meet data center reduction goals included in the Federal Data Center Consolidation Initiative. A final data center count has been established by the NASA CIO for each Center location, and all NASA Centers are executing their consolidation activities in parallel. LaRC's goal is to consolidate five data centers into the new Computational Research Facility scheduled to be constructed by the end of FY 2016.

LaRC's OCIO completed a Data Center Consolidation Study in FY 2011, which describes how consolidation of LaRC data centers can be achieved in a meaningful and productive fashion, primarily by relocating data center resources into fewer locations. The remaining three data centers identified in the study—Mission Data Center, OCIO Data Center, and Science Data Center—have been identified by the Agency consolidation team as requiring power usage effectiveness (PUE) metering to measure the savings from energy related improvements. By the end of FY 2012, the required metering had been installed within the three data centers. In FY 2014, the Center Operations Directorate (COD) began implementing an agency Condition Based Monitoring tool that will result in the additional instrumentation of various kinds of equipment across the Center beginning with critical items such as data center uninterrupted power supply devices.

Data center consolidation activities initially focused on the absorption of the smaller or less efficient data centers and consolidation of server rooms into one of the three remaining data centers, with the intent to increase utilization density in these data centers. As of FY 2015, a total of 22 server rooms and 5 data centers have been closed, with all associated IT equipment either decommissioned or consolidated into one of the three remaining Agency monitored data centers.

LaRC's OCIO also completed a Data Center Analysis Report in FY 2011, which determines where improvements in data center efficiency and effectiveness can be made and recommendations on how to improve them. The OCIO continues to incorporate recommendations by the Agency and its own data consolidation study to consolidate and reduce energy costs through more efficient use of the existing conditioned spaces, employing best practices in room design, proper temperature settings, optimal rack

and floor space densities, and life cycle replacement of old and inefficient hardware. The OCIO attempts cost avoidance by better utilizing the existing data center infrastructure so that expensive increases in power and cooling capacity are not necessary.

### 7.3 Highlights

The following initiatives highlight LaRC's progress toward these objectives:

- The OCIO provided 3 additional virtual server environments in FY 2015.

- LaRC continued its participation in an Agency-wide effort to develop an enterprise solution for computer power management. This aggressive power management approach includes putting computers to sleep or in hibernation mode when not in use, a practice currently not allowed in order to facilitate software pushes, patches, and backups. Two LaRC personnel volunteered to test ACES' solution and worked through six different versions of the power management software. ACES deployed an Agency-wide pilot of the software in early FY 2015, which was followed by an analysis of results and user comments. ACES is currently working to recommend a solution in order to reduce energy use of computers when not in use.

- In FY 2014, LaRC and the U.S. Army Corps of Engineers completed developing the two-phase Design-Build solicitation package for a state-of-the-art consolidated data center, the Computational Research Facility, which will allow for advanced computational research and development in a new, energy efficient, and sustainable facility. The 40,000-square-foot building will house high-end computational assets and approximately 110 employees. It will pursue a LEED Silver certification and consolidate LaRC's data centers and over 30 server rooms into one single location with shared support infrastructure and security allowing for advanced monitoring systems resulting in improved efficiencies in the areas of power consumption, cooling and humidity control requirements, reliability and capacity optimization. The Design-Build construction contract was awarded at the beginning of FY 2015. Construction began 1st Quarter, FY 2016, and is projected to be completed in FY 2017.

# 8 Goal 8: Renewable Energy

## 8.1 Goal Description

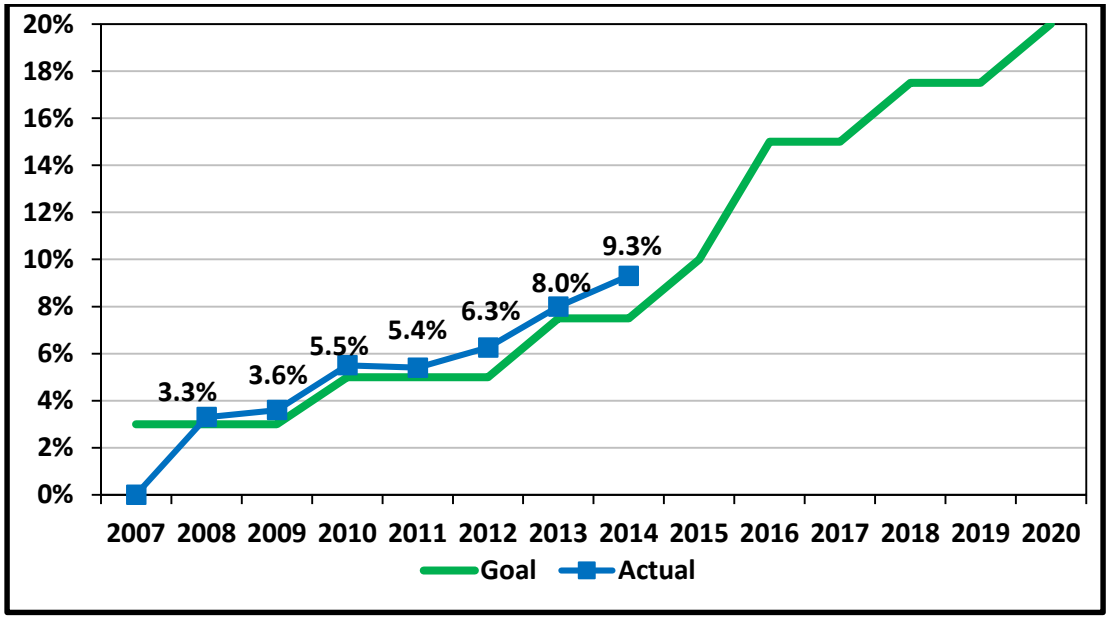
**For FY 2013 and beyond, 7.5% of total electricity consumption is from renewable energy sources.**

## 8.2 Center Status

LaRC meets the renewable energy requirement through the purchase of Renewable Energy Credits (RECs). Each year, the Center purchases RECs in amounts equal to or greater than the EO requirements. In FY 2015, LaRC purchased 10,500 Megawatt hours (MWh) of RECs and generated 141.4 MWh (with allowable double-counting for generation of renewable energy at a federal facility) of renewable solar energy for a total of 10,541 MWh of renewable energy. This amount of renewable energy for FY 2015 is equivalent to 7.73% of the Center's total FY 2015 electricity consumption of 137,737 MWh.

In FY 2012 LaRC registered its solar photovoltaic systems in the Pennsylvania REC market in anticipation of possible future opportunities to sell or trade those RECs for the benefit of the Center. In FY 2015 the Center continued its efforts to realize the economic benefit of these RECs.

**Figure 4 - Renewable Energy at LaRC**




## 8.3 Highlights

- LaRC continued to investigate opportunities for implementing renewable energy projects at the Center. The Center submitted a 500-kW solar photovoltaic (PV) energy project for consideration under NASA HQ's Construction and Environmental Compliance and Restoration (CECR) funding process, but the project was not selected.

- The Center held discussions with Dominion Virginia Power on the option of leasing land or developing a power purchase agreement (PPA) for solar PV. These discussions will continue in FY

2016 for possibly entering into a Utility Energy Services Contract (UESC) with Dominion Power with rough order of magnitude (ROM) cost estimates of $2.9 million for a 1 MW installation to $24 million for a 10 MW project.

# 9 Goal 9: Climate Change Resilience

## 9.1 Goal Description

**Evaluate climate change risks and vulnerabilities to identify and manage the effects of climate change on the Center's operations and mission in both the short and long term.**

## 9.2 Center Status

LaRC has evaluated climate change risks and vulnerabilities and identified the primary risks to be sea level rise, hurricanes, and increased precipitation and temperature. LaRC utilizes the following mechanisms to evaluate these risks and manage their potential effects on operations, mission, and infrastructure: the Center Master Plan, the GIS Flood Impact Analysis Tool, the environmental impact review process, and partnerships with key Federal, State and local stakeholders on climate change resilience initiatives.

## 9.3 Highlights

The following initiatives highlight LaRC's progress toward identifying and managing the effects of climate change at the Center:

- As part of LaRC's Master Plan and revitalization initiatives, LaRC continues to demolish outdated, inefficient, and underutilized buildings while consolidating and storm-hardening critical infrastructure. The demolition of eight East Area facilities (large wind tunnels and support facilities) over the past three years has greatly reduced potential risks to LaRC infrastructure caused by sea level rise.

The LaRC GIS Team continues to support the Center's climate change resilience initiatives to include:

- Procured an Unmanned Aircraft System which provides 1.5-inch resolution imagery more frequently and cost effectively to help with change detection. As of January 2016, awaiting approval for proficiency certification and initial data gathering efforts.

- Refined outfall data and ran the existing spatial data through new elevation analysis tools to better define areas which feed various storm water outfalls. Completion of a full 3D model for storm systems to support network analysis is planned by May of 2016.

- Continued work on re-observing the existing control network at LaRC and processing against Continuous Operation Reference Station data to provide rough subsidence values for the preceding 18 years.

- Worked with the National Geodetic Survey (NGS) to provide the best possible measurement capabilities to quantify subsidence at LaRC and the surrounding area for the long run (decades). The initial piers and measurement systems have been installed. Future work will include installation of shallow and deep complimentary monuments, a NGS leveling class, and official observation after first freeze/thaw in early Spring of 2016.

- Worked with the US Geological Survey to install a high resolution tide gauge replacing the basic version that was previously installed at LaRC's Construction Debris Landfill site. The gauge is operational and the GIS Team is working solutions to provide continuous real time data for the Emergency Operations Center to feed the new Flood Impact Analysis Tool.

- All components of the new Flood Impact Analysis Tool have been developed and are working in a Development environment. The fully functional new capability (with new imagery for LaRC) is expected by the end of January 2016.

- The GIS Team suggested to LaRC's Science Directorate, and offered GIS Team services, to use LaRC/LAFB for ground truth of an Interferometric SAR (InSAR) prototype effort that they are coordinating with NOAA. InSAR is a NASA satellite that will revolutionize ground displacement measurements, as well as aid in the development of determining climate change and detecting natural hazards.

# 10 Goal 10: Energy Performance Contracts

## 10.1 Goal Description (Agency Goal)

**For NASA, award $73.9M in Energy Savings Performance/Utility Energy Service Contracts by the end of FY 2016.**

## 10.2 Center Status

The Center does not have any ESPC/UESC projects in progress at this time. Energy Performance Contracts, including both ESPCs and UESCs, enable agencies to obtain energy efficiency investments in buildings and deploy on-site renewable energy through long-term contracts with the private sector, which are in turn paid through savings derived from those investments.

In tracking this goal at the Agency level, NASA pledged $19.6 million investment value for the December 2011 Presidential Memorandum requiring the Federal Government to contract for $2 billion of energy efficiency investments by the end of FY 2013. NASA became the first agency to meet its investment value pledge, and Centers awarded energy projects totaling nearly $45.7 million investment value under ESPCs and UESCs in FY 2012–FY 2013.

NASA increased its pledge to $73.9 million total investment value in response to the Administration's extension/expansion of the energy performance contracting goal to $4 billion by the end of FY 2016.

The Agency does expect each Center to pursue every feasible opportunity to engage in ESPCs or UESCs, and each Center is required to annually submit its plans for these contracts, including project scopes and funding levels. In FY 2013, LaRC commissioned a feasibility study for a second UESC project. However, the study did not identify any viable projects with acceptable economic payback, and therefore the Center did not pursue a UESC. LaRC receives a "green" rating in this category for having completed the feasibility study although no UESC is in place at this time.

## 10.3 Highlights

In FY 2015, LaRC continued on-going discussions with Dominion Virginia Power for possibly entering in to a UESC with Dominion Power for a new solar installation with ROM cost estimates of $2.9 million for a 1 MW installation to $24 million for a 10 MW project.

# 11 Executive Order 13693 Goals

To facilitate planning and reporting, the majority of the goals for EO 13693 took effect in the beginning of FY 2016 and are therefore appropriate for inclusion in the EMSP. As noted previously, most of the goals that LaRC pursued under the previous Executive Orders have been carried over into EO 13693. The EO renamed and renumbered some of the goals. The 10 goals listed below are those for which LaRC presents implementation methods and ideas for program improvement going forward and against which LaRC will report status updates in the next EMSP update.

## 11.1 GOAL 1: Greenhouse Gas (GHG) Reduction (Agency Goal)

**Reduce direct GHG emissions (Scope 1 and 2) by 47% and indirect emissions (Scope 3) by 32% by FY 2025, compared to FY 2008.**

Implementation Methods and Planning Actions

To support achievement of the Agency GHG reduction goals, NASA LaRC plans to:

- Continue to optimize operation of the high-efficiency Cleaver-Brooks/Nebraska boiler.
- Continue collaboration with the Waste to Energy Plant to minimize the amount of steam generated, and fuel used, by the LaRC boilers. The steam line connection repairs are scheduled for completion in FY 2016.
- Track progress of EPA's update to the refrigerant management requirements under the Clean Air Act (Federal Register 11/9/15). One goal of the update is to reduce GHG emissions, although it would increase regulatory compliance requirements. Many refrigerants, including ozone-depleting substances (ODSs) and their substitutes, are GHG with high global warming potential. Some of the proposed changes include mandatory quarterly or annual leak inspections, forced retirement of chronically leaking systems, lower leak rate trigger for mandatory repairs, and having to repair all known leaks (not just enough to reduce the leak rate below trigger level).
- Implement key energy reduction efforts as described in Section 11.2 (Sustainable Buildings) of this Plan.
- Implement fleet management strategies as described in Section 11.5 (Fleet Management) of this Plan.
- Actively pursue initiatives as described in Section 11.3 (Clean and Renewable Energy) of this Plan.

LaRC personnel will continue to provide key Center-specific data to the NETS database. This data will be utilized by NASA HQ staff for annual GHG emissions reporting and tracking. To stay abreast of new GHG developments and requirements, SPEEB staff will continue to participate in the routine teleconferences organized by the NASA Regulatory Risk Analysis and Communication (RRAC) Principal Center. These teleconferences provide a forum for the Agency GHG lead to disseminate new GHG requirements and for GHG issues to be discussed.

Opportunities for Program Improvement

Although NASA HQ anticipates that key energy reduction efforts will contribute to achievement of projected reduction targets, there are some potential opportunities for reducing LaRC GHG emissions, including the following:

a. Perform a technical evaluation of the R-134a gas reclaim system at the TDT to determine if operational improvements and/or equipment upgrades could be implemented to increase reclaim efficiency of R-134a and reduce losses of this gas to the atmosphere during operation. R-134a is a GHG that must be included in the Agency GHG inventory. Any reductions of R-134a at LaRC will contribute to achievement of the Agency reduction goal.

b. Evaluate the feasibility of converting the building heating systems for the three buildings (1228, 1297, 1297C) that are currently heated with #2 Fuel Oil to steam-heated systems. This would reduce the quantity of #2 fuel oil combusted at the Center with a corresponding reduction in GHG emissions.

c. In January 2016, high voltage electricians working under the Jacobs CMOE contract identified a minor leak of sulfur hexafluoride gas in a switch on a transformer in the east area at LaRC. $SF_6$ is a GHG with global warming potential of 22,800 times that of carbon dioxide. Jacobs is working to locate and repair the leak which will reduce GHG emissions. The potential for other leaks could also be evaluated.

## 11.2 GOAL 2: Sustainable Buildings (Including Energy Conservation and Data Centers)

***Facility Energy Use Intensity*: Reduce energy consumption/GSF of building area by 2.5% annually from FY 2015 baseline for FY 2016 – FY 2025 (25% total reduction).**

***Net Zero Energy Buildings*: Beginning in FY 2020, ensure all new construction that enters the planning process will be designed to achieve net-zero, and where feasible, water or waste net zero by FY 2030.**

***Sustainable Buildings*: At least 15% of Agency's existing buildings meet Guiding Principles by FY 2025.**

***Data Center Efficiency*: Install and monitor advanced energy meters in all data centers by FY 2018. Establish a Power Usage Effectiveness (PUE) target of 1.2 to 1.4 for new data centers and less than 1.5 for existing data centers.**

Implementation Methods and Planning Actions

**Facility Energy Use Intensity:**

LaRC achieves energy conservation through implementation of energy efficiency projects and through employee awareness. These efforts are overseen by the Energy Manager and involve personnel and facilities across the entire Center.

In FY 2015, NASA HQ required that the Center's Energy Efficiency and Water Conservation 5-Year Plan be updated using a new template and renamed the Energy Conservation Performance Plan (ECPP). The ECPP was updated in FY 2015 to conform to this new, expanded template. In early FY 2016, NASA HQ required the ECPP to address a 10-year plan, now due on April 15th, 2016. This plan will outline the Center's progress towards conservation goals, proposed actions, and impacts of those actions towards meeting the goals. The plan will also list specific projects identified to meet EO 13693 goals over the next 10 years. Energy Program staff will be working with the Center's Energy Efficiency Team (EET) to identify projects and complete this plan in early FY 2016 for signature by the Center Director.

Energy Program staff are drafting a Center Plug Load Management Plan policy document that will be referenced in LPR 8500.1. The plan will outline the policy on personal appliance and device usage in facilities and the approval process for these to minimize the impact of plug load on energy consumption at facilities. The policy document is expected to be completed in early FY 2016 for inclusion in LPR 8500.1.

LaRC's EET continues to improve energy conservation communication and project implementation across LaRC. The EET is a diverse group consisting of members from various Center directorates. The committee provides direction and guidance regarding implementation of various conservation activities at the Center, meeting three to four times each year to discuss the latest events and projects regarding energy and water conservation. In Q3 of FY 2015, LaRC Energy Program staff held a workshop with the EET to identify energy efficiency and water conservation projects. These projects are still being evaluated. Feasible projects from this process will be an integral part of the 10-year ECPP.

NASA's Energy Efficiency Panel (EEP) is comprised of representatives from NASA HQ, each Center, other organizations, and support contractors to ensure appropriate coverage of program requirements. NASA LaRC Energy Program staff participate in this panel.

EISA 2007 requires annual energy use benchmarking of each metered building within an Agency's covered facilities. Benchmarking provides comparison of a building's energy performance against itself over time and against a database of similar buildings, which assists in prioritizing comprehensive energy/water building evaluations and building tune-up efforts. The Department of Energy has designated ENERGY STAR Portfolio Manager as the required benchmarking system. Every quarter LaRC enters monthly energy consumption data for each Goal Subject building into the ENERGY STAR Portfolio Manager tool. The benchmarking data is updated as required in the web-based Compliance Tracking System (CTS) developed by the Secretary of Energy to track compliance with Section 432 of EISA.

In FY 2016, Energy and Water Conservation is once again identified as a high Environmental Management System (EMS) priority, with the goal to reduce energy in Goal Subject facilities by 2.5% annually in order to meet new EO 13693 goals. To contribute toward this goal, LaRC will continue to implement energy conservation projects.

The largest facility projects that will impact energy consumption at LaRC in the near future are Phase 3 and 4 of the LaRC revitalization program. In Phase 3, the Center is constructing a new Computational Research Facility (CRF). When completed in FY 2017, this 40,000 square foot facility will house a highly efficient data center in which most of the Center's computing power will be consolidated. The facility will be LEED Silver certified, 30% more efficient than a baseline facility of its type, and is designed to have a PUE of 1.5. In Phase 4, LaRC will construct a 175,000 square foot Measurement Systems Lab (MSL). MSL will contribute to reductions in the Center's energy consumption through lower energy intensity and associated demolitions. Conceptual planning for MSL began in FY 2012, with construction slated to begin in FY 2016 and beneficial occupancy to occur in FY 2019.

Other reductions in energy usage are expected as older buildings are demolished and as the Center continues to implement Construction of Facilities (CoF) and Maintenance projects that increase energy efficiency of facilities, equipment, and operations. LaRC also plans to pursue the specific strategies detailed below:

- Complete repairs and energy conservation measures identified in retro-commissioning projects.
- Continue the program to incorporate energy management data into GIS.
- Continue the small energy project funding process for FCs and FECs across the Center.
- Continue to pursue a contract to trade LaRC's Solar Renewable Energy Certificates (SRECs) for wind/biomass RECs. This pilot project will establish the legality and feasibility to trade higher value

SRECs for multiple less valuable RECs, allowing LaRC to maximize the REC impact of its solar renewable energy production.

- Continue training FCs and FECs in facility energy management through annual FEC training, LaRC Health & Safety Days training, and quarterly FC and Facility Safety Head meetings.

- Complete annual facility energy and water audits.

- Continue development of Facility Design Standards and accompanying energy efficiency requirements.

**Net Zero Energy Buildings:**

Through the NASA EEP, in FY 2014 LaRC Energy Program personnel contributed to the development of the "NASA Net Zero Energy Buildings Roadmap," to prepare for the time-phased net zero energy buildings (NZEBs) requirement for new federal buildings starting in 2020. This roadmap presents a high-level approach to NZEB planning, design, construction, and operations. This same roadmap will be utilized for NZEB planning for EO 13693 requirements. In addition, further federal guidance is anticipated to aid in meeting EO 13693 goals.

**Sustainable Buildings:**

NASA has adopted LEED as its performance measure for sustainable development and has mandated a LEED Silver rating for all new construction and major renovation projects. The Facilities Engineering and Real Property Division at NASA HQ provides guidance on sustainable facilities design and construction and periodically assesses progress of the sustainable design program at each of the NASA Centers.

The extent by which sustainable design principles are adopted differs due to each individual project's requirements. Facility projects include minor maintenance projects, facility revitalization, and new construction. Centers are instructed to evaluate their project results during the initial implementation of sustainable design using the LEED Green Building Rating System. The fourth new building of LaRC's revitalization plan, the Measurements Systems Laboratory (MSL), is expected to break ground in FY 2016. As LaRC's first major new laboratory construction in decades, this facility is expected to achieve a minimum LEED Silver certification.

LaRC's Revitalization Program Office ensures that LaRC's planning and development strategies focus on high performance sustainable design and green building, and that the strategies are incorporated into the Center's Master Plan. SPEEB staff coordinate with the Revitalization Program Office and Project Managers to ensure cost-effective, innovative, and sustainable strategies are incorporated into project design plans. Staff also ensure that environmental impact reviews for proposed new or modified facilities identify and analyze impacts associated with energy and climate change, where appropriate and practicable.

LaRC's Environmental Management Committee and LaRC's EET provide additional oversight and feedback regarding sustainability features of the Center's projects and operations to ensure specified goals are met.

LaRC utilizes the expertise and flexibility provided by the USACE Master Support Agreement to ensure that high performance sustainable design and green building strategies are incorporated into project design plans to the maximum extent possible.

**Data Centers:**

The Center is currently constructing a new Computational Research Facility (CRF) which will become the central data center for LaRC. This 40,000 square foot facility will house a highly efficient data center in which most of the Center's computing power will be consolidated. The facility will be LEED Silver certified, 30% more efficient than a baseline facility of its type, and is designed to have a Power Usage Effectiveness (PUE) of 1.5. The EO requirement of a 1.5 PUE for existing facilities applies to this project based on the timing of design and funding of the project. The facility is scheduled to be completed in the second quarter of FY 2017. Any new data centers in the future will be required to meet more stringent 1.2-1.4 PUE requirements.

Opportunities for Program Improvement

**Facility Energy Use Intensity:**

Several opportunities exist for improving and strengthening the energy program at NASA LaRC including:

a. A more comprehensive energy monitoring program could be established to regularly analyze building-level energy usage and investigate opportunities for optimization of building systems. The Energy Advisor pilot study provides one mechanism for this kind of monitoring. The new Struxureware Power Monitoring Expert software allows for user friendly report functions using virtual meters designed for buildings as well as the capability of creating dashboards for individual buildings as a useful outreach tool.

b. A specific Energy Awards program could be established at LaRC to recognize Center employees who develop viable energy reduction project ideas. Since Center employees are intimately familiar with the processes and equipment in their facilities, they may be able to identify project opportunities of which Center energy personnel may not be aware.

c. A mandatory energy awareness training program could be implemented for Center employees. The training program would emphasize Federal energy reduction goals and highlights of the various prescribing documents (ex. EO 13693, EPAct of 2005). The program could be web-based and administered through NASA's System for Administration, Training, and Educational Resources (SATERN). Increasing employee awareness would support achievement of energy reduction goals.

d. The Center uses steam for many of its operations. Excess steam could be converted to electricity through system upgrades and new conversion equipment at the LaRC Steam Plant or at the Waste to Energy Plant. While this is currently an expensive project, it may become more cost effective as technology improves over time. As an alternative to electricity generation, LaRC could utilize additional absorption chillers to more efficiently manage the steam load during the summer months. As mentioned earlier, LaRC contracted a study with the National Renewable Energy Laboratory (NREL) to investigate similar options for optimization of steam supply from the Waste to Energy Plant facility.

e. Reduction of night lighting at the Center presents an opportunity for energy efficiency. A large number of lights are left on during the night due to safety concerns or lack of switching off. Continuing to install occupancy sensing switches and providing the appropriate amount of night lighting to meet safety concerns has the potential to further reduce a portion of the Center's energy use. Data loggers could be utilized for random or targeted facilities to monitor night and weekend lighting concerns.

Beyond FY 2016, the only approved energy-related projects are the two Revitalization construction projects described earlier (CRF and MSL). Several "shovel-ready" projects have been identified by the Energy Management Program that LaRC is unable to fund within current budget constraints, including the following:

f. The energy efficiency of LaRC's service compressed air system could be improved. LaRC's Building 1215 steam plant supplies 110 pounds per square inch gauge (PSIG) service air to the Center using two large (500 horsepower/450 horsepower) air compressors and an electrically heated desiccant

drying system. This system requires an average power demand of 500 kW, making Building 1215 one of the five highest power consuming buildings on Center. At current conditions, the system is oversized by an estimated 30%, requiring compressed air to be vented to atmosphere to avoid over pressurizing the system. By re-sizing one of the air compressors to more closely match demand, and replacing the electric air dryer system with a heat of compression (HOC) system that uses hot discharge air from the compressor for drying, the Center can reduce its current air system power demand by almost half. However, Center-wide demand must be further evaluated, including potential power demand reduction through an aggressive leak repair and prevention program, as well as future demand savings/increases resulting from the Revitalization program.

g. Implementation of a renewable energy generation project. For example: a one megawatt (MW) solar photovoltaic (PV) system could be installed with an estimated FY 2016 installation cost of $2.9M. The system's annual electricity production is projected at 1,270,500 kWh. At LaRC's FY 2016 projected average cost for electricity, the system's annual cost avoidance is $73.3K for a simple payback of 39.5 years.

At this time, there is no budget for non-mission critical energy efficiency projects at LaRC, and none of the above projects have been designated mission critical.

**Net Zero Energy Buildings:**

LaRC will utilize the NASA Net Zero Energy Buildings Roadmap to prepare for the time-phased NZEBs requirement for new federal buildings starting in FY 2020. This roadmap presents a high-level approach to NZEB planning, design, construction, and operations. Implementation instructions are expected to accompany new Net Zero requirements in EO 13693 in the near future and will be beneficial to LaRC in planning for this requirement. Clarification of source energy requirements and other considerations will provide a clearer picture as we move forward.

**Sustainable Buildings:**

Several opportunities exist for improving and strengthening the sustainable design program including the following:

a. LaRC's Energy and Utilities Managers, as well as COD Engineering, could identify new projects or buildings where sustainable design would be applicable.

b. Implementation of a robust training program to disseminate sustainable design and green building information to key Center personnel involved in facility and project planning and design.

c. Expand collaboration with local and regional entities regarding strategies for future sustainable development and to address challenges associated with future climate change impacts.

d. Consideration of LEED for Existing Buildings (Operations and Maintenance) certification for buildings that may meet, or that could be readily upgraded to meet, the minimum qualifications. LEED for New Construction (LEED-NC) certified buildings can also be certified as LEED for Existing Buildings following one continuous year of operation which signifies that the building is meeting all design parameters.

**Data Centers:**

The Center will continue to optimize building systems and existing data centers to meet the existing data center requirements. Consolidation of data centers into the new CRF facility will greatly improve LaRC's position in meeting these data center PUE requirements.

## 11.3 GOAL 3: Clean and Renewable Energy

***Clean Renewable Energy*: Ensure that the percentage of the total amount of building electric and thermal energy consumed shall be Clean Energy, accounted for by renewable electric energy and alternative energy that is not less than: FY 2016 - FY2017, 10%; FY 2018 - FY 2019, 13%; FY 2020 – FY 2021, 16%; FY 2022 – FY 2023, 20%; FY 2025, 25%, and each year thereafter.**

***Renewable Energy*: Ensure that the percentage of the total amount of building electric energy consumed that is renewable energy is not less than: FY 2016 - FY2017, 10%; FY 2018 - FY 2019, 15%; FY 2020 – FY 2021, 20%; FY 2022 – FY 2023, 25%; FY 2025, 30%, and each year thereafter.**

Implementation Methods and Planning Actions

Since 2008, LaRC has been meeting the renewable energy requirement through the purchase of RECs. Each year, the Center purchases RECs in amounts equal to, or greater than, EO requirements. Since FY 2012, the Center has purchased only "new" RECs from sources placed into service after January 1, 1999.

LaRC does have onsite generation of renewable energy. In FY 2010, the Center installed a 39.5 kilowatt (kW) solar array behind Building 1308, the Center's Badge and Pass Office. This solar array is tied directly into the LaRC grid at Building 1308. LaRC also installed a 22 kW solar roof array and a 1.5 kW thin film skylight in Building 2101, which was completed in FY 2011. These three installations produced approximately 141.4 MWh of energy in FY 2015.

Electricity RECs produced by these installations are eligible for "double counting" (as allowed by EPAct 2005 for RECs produced on a Federal site). LaRC received 141 RECs for onsite renewable energy production, bringing the Center's total RECs to 10,641 MWh, or 7.73% of total FY 2015 electricity consumption.

LaRC's onsite renewable energy production capacity also includes two operational ground source heat pump systems for building heating and cooling (Buildings 2101 and 2102). At this time neither system is included in LaRC's annual renewable energy calculations.

Since LaRC's current solar PV installations produce less than 100 MWh/year, even with the "double counting" of RECs produced onsite they will not make a significant contribution to meeting LaRC's annual renewable energy requirement. Therefore, LaRC expects to continue to meet its requirement through the purchase of RECs.

In accordance with EO 13693, all RECs purchased in FY 2015 and beyond must be sourced from new sources, those placed into service within 10 years prior to the start of the fiscal year. For FY 2015, 10% of total electricity consumption must come from new renewable energy sources. For FY 2016 – FY 2017, the requirement increases to 15%; for FY 2018 – FY 2019, the requirement increases to 17.5%; and in FY 2020, the requirement increases to 20%.

In addition to the renewable electric energy sources listed above, LaRC generates a significant amount of thermal energy at the Waste to Energy Plant. Previously, this thermal energy was not included in renewable energy credits, but EO 13693 goals require that by FY 2025, Federal facilities must account for 25% of total thermal and electric energy from Clean Energy, which now includes alternative energy generated from waste to energy facilities. Therefore, continued operation of the Waste to Energy Plant has the potential to account for a significant amount of total energy generated from alternative sources. For example, a recent calculation confirmed that the Waste to Energy Plant accounted for 36% of total energy use at LaRC in FY 2014. LaRC will continue to pursue the appropriate approval from NASA HQ for the use of steam generated by the Waste to Energy Plant to count toward EO 13693 Clean Energy goals.

Opportunities for Program Improvement

Opportunities exist for improving and strengthening the renewable energy program at LaRC, including the following:

a. Implementing a renewable energy generation project, such as installation of a new solar PV system. LaRC continues to investigate opportunities for implementing renewable energy projects at the Center. The Center submitted a 500-kW solar PV energy project for consideration under NASA HQ's Construction and Environmental Compliance and Restoration (CECR) funding process, but the project was not selected. The Center has held discussions with Dominion Virginia Power on the option of leasing land or developing a power purchase agreement (PPA) for solar PV. Ongoing discussions continued in FY 2015/2016 for the possibility of a Utility Energy Services Contract (UESC) with Dominion Power with ROM cost estimates of $2.9 million for a 1 MW installation to $24 million for a 10 MW project.

b. Implement recommendations presented in the result of the Waste to Energy Plant Optimization Study conducted in FY 2015-2016. The Waste to Energy Plant produces an average of 100 million pounds of unused steam annually that is vented to atmosphere.

c. Implementing a REC trade agreement to trade LaRC's SRECs for wind/biomass RECs. This pilot project will establish the legality and feasibility to trade higher value SRECs for multiple, less valuable RECs, allowing LaRC to maximize the REC impact of its solar renewable energy production.

d. Collect measurable data to account for renewable energy generated by the ground source heat pumps ("geothermal") installed for Buildings 2101 and 2102. LaRC has not accounted for this energy due to the complexity of calculating the RECs. These RECs, if accounted for, could reduce the number of RECs the Center has to buy each year. This would allow for more funding to be applied to other energy and water conservation projects.

e. Pursuing one of the research projects at LaRC that involve new energy technologies, such as wind power. LaRC Energy Program staff could become more involved in these projects, facilitate faster development, or new areas of research through funding and/or advocacy. Energy Program staff began discussions with the LaRC Office of Strategic Analysis, Communications, and Business Development (OSACB) in FY 2015 to determine the possibility of involving the Tech Transfer office in developing renewable energy projects. Efforts will continue to keep this dialogue moving forward.

f. Accelerating implementation of Net Zero energy buildings ahead of the FY 2020 design for Net Zero energy deadline/FY 2030 Net Zero energy performance deadline. Significant coordination across the Center Operations Directorate, up to, and including, the highest levels of Center and Agency management would be needed.

## 11.4 GOAL 4: Water Use & Efficiency Management

**Reduce potable water consumption 2% annually by FY 2025 relative to FY 2007 baseline.**

**Reduce industrial, landscaping, and agricultural water consumption 2% annually by FY2025 relative to FY2010 baseline.**

**Install green infrastructure to help with storm and waste water management.**

Implementation Methods and Planning Actions

LaRC uses large volumes of water for daily operations, research activities, and energy production. The largest usage areas of potable water at the Center are steam production, cooling towers, and personal hygiene. The Center's Utilities Manager and Energy Manager are responsible for managing water efficiency

and conservation program activities, monitoring the Center's water usage, identifying water conservation opportunities, and reporting water consumption data.

Water conservation at the Center is achieved through employee awareness, identification and repair of leaks, and implementation of water conservation projects. Water use intensity is reported in NETS for tracking progress towards achievement of water reduction goals.

The Center maintains an Energy Efficiency and Water Conservation 5-Year Plan that is updated every three years. The plan outlines the Center's progress towards conservation goals, and the proposed actions and impacts of those actions, towards meeting LaRC's conservation goals. In FY 2015, NASA HQ required that the Center's Energy Efficiency and Water Conservation 5-Year Plan was updated using a new template and renamed the Energy Conservation Performance Plan (ECPP). The ECPP was updated in FY 2015 to conform to this new, expanded template. In early FY 2016, NASA HQ required the ECPP to address a 10-year plan, now due on April 15th, 2016. This plan will outline the Center's progress towards conservation goals, proposed actions, and impacts of those actions towards meeting the goals. The plan will also list specific projects identified to meet EO 13693 goals over the next 10 years. Energy Program staff will be working with the Center EET to identify projects and complete this plan in early 2016 for signature by the Center Director.

The LaRC EET also supports water conservation communication and project implementation across LaRC. The EET is a diverse group consisting of members from various Center directorates. The committee provides direction and guidance regarding implementation of various conservation activities at the Center, meeting three to four times each year to discuss the latest events and projects regarding energy and water conservation.

NASA has established a Water Management community of practice consisting of representatives from NASA HQ and each Center, other organizations, and support contractors to ensure appropriate coverage of program requirements. NASA LaRC personnel participate in this community of practice.

In FY 2016, Energy and Water Conservation is once again identified as a high environmental EMS priority, with the goal to reduce LaRC's water consumption by 2% annually. To contribute toward this goal, LaRC plans to implement the following energy and water conservation projects in FY 2016:

- Complete Energy Efficiency Improvements Project for Retro-commissioning of 17 buildings and Lighting Retrofit in Building 1195 Complex.
- Complete Steam Meter Installation Project by the end of FY 2016.
- Continue the small energy and water project funding process.
- Use recently installed zone metering in sanitary sewer systems to more efficiently identify water consumption and discharge anomalies.

In an effort to reduce water consumption and to continue to achieve water reduction goals, several specific strategies are being pursued, as detailed below.

- Continue training FC/FECs in facility energy and water management through the SPEEB's annual FEC training and through the quarterly FC/FSH meetings. This training focuses on identifying energy and water conservation measures in facilities.
- Continue facility energy and water audits.
- Perform maintenance tasks and implement energy conservation measures identified by task to retro-commission 17 Goal-Subject buildings.

- Continue the Center-wide assessment of Energy Management Control System (EMCS) HVAC run schedules.

- Review new operations and construction projects for water conservation opportunities.

The Revitalization Program will have a positive impact on the Center's water consumption reduction. The first building, Building 2101, uses 6.6 Gal/GSF annually, much lower than the estimated 13.7 Gal/GSF used domestically on Center (domestic water is total LaRC water usage less water for steam and cooling towers). Future Center buildings are expected to perform at or near this level.

Implementation of green infrastructure for storm and wastewater management is achieved through the Water program at LaRC, where Center Municipal Separate Storm Sewer System (MS4) permit requirements and the Chesapeake Bay Total Maximum Daily Load (TMDL) are driving the installation of stormwater management controls both for new construction and for the Center as a whole. These initiatives and requirements are outlined and described in detail in the LaRC MS4 Program Plan. To date, several projects have been completed for stormwater management including, bioretention for new construction sites, tree box filter retrofits of drop inlets throughout the Center, and numerous water quality tree plantings. Future implementation of this goal will be largely directed through the stormwater compliance program and through the MS4 Program Plan.

Opportunities for Program Improvement

Several opportunities exist for improving and strengthening the water management program at NASA LaRC, including the following:

a. A specific Water Conservation Awards program could be established at LaRC to recognize Center employees who develop viable water conservation project ideas. Since Center employees are intimately familiar with the processes and equipment in their facilities, they may be able to identify project opportunities of which Center water management personnel may not be aware.

b. A mandatory water conservation training program could be implemented for Center employees. The training program would highlight Federal water reduction goals and the various prescribing documents (ex. EO 13693). The program could be web-based and administered through SATERN. Increasing employee awareness would support achievement of water reduction goals.

c. LaRC could evaluate additional water reclamation/reuse projects such as rainwater harvesting and utilization of A/C condensate. Currently, there are several water users connected to the municipal water system that could utilize water that is less than potable quality. Utilizing alternative water sources such as rainwater or A/C condensate would reduce the water usage intensity of the Center.

d. EET members could encourage others in their organizations to conserve water and to submit water saving ideas to the LaRC Energy Manager for evaluation.

e. Additional funding will be needed to meet Chesapeake Bay TMDL requirements and projects for stormwater management in later cycles of the MS4 permit.

Several "shovel-ready" projects impacting water consumption have been identified by the Energy Management Program that LaRC is unable to fund within current budget constraints, including the following:

f. Potable Water Supply and Metering: Construction of Facilities (CoF) funding was expected in FY 2016 for a project to replace existing underground potable water piping and valves and install 15 advanced water meters in LaRC's potable water distribution system. Advanced water meters for 33 buildings/complexes were also included in the CoF Potable Water Project, Phase 2. Funding for the project was cut in January 2016.

g. Installation of advanced meters on cooling towers. Cooling towers are major water users on Center, with leaks, valve malfunctions, and other issues, causing a significant amount of unnecessary water loss each year. While LaRC's major cooling towers are metered, the meters are not "smart" meters and are read manually once a month. Installation of smart meters with connection to the EMCS over the newly-installed mesh wireless network on Center (a project estimated to cost $448K), will allow real-time monitoring of cooling tower water usage and much faster identification of leaks and other problems.

## 11.5 GOAL 5: Fleet Management

**Reduce fleet wide per mile GHG emissions 30% by FY 2025 relative to FY 2014 baseline.**

**Ensure zero emission vehicles or plug in hybrids account for 20% of new fleet acquisitions by FY2020 and 50% by FY 2025.**

Implementation Methods and Planning Actions

The Logistics Management Branch (LMB) continues to assess the vehicle fleet for opportunities to reduce unnecessary vehicles while maintaining a fleet size appropriate to meet mission needs. A Vehicle Utilization Review Board (VURB) is used to optimize vehicle resources. The current fleet size is 97 vehicles including 25 E-85 vehicles. Low speed electric vehicles do not count toward the fleet vehicle inventory of 97, since they are not licensed to drive off Center. NASA LaRC will continue to eliminate underutilized vehicles, right size the fleet, and increase the acquisition of low and zero greenhouse gas emitting vehicles.

In FY 2016, there are plans to acquire the following:

- Four low speed electric vehicles.
- If funding allows, two alternative fuel light duty (pickup) trucks.

The LMB oversees the types of vehicles making up the fleet. As funding allows, older less efficient vehicles are replaced with newer more efficient vehicles. Fleet vehicles are used only for on Center transportation needs and within a 50 mile radius. Long distance travel use of LaRC fleet vehicles was discontinued in FY 2008. LaRC's travel fleet was eliminated in 2007, and passenger vehicles were eliminated in 2009. The vehicle maintenance department tracks mileage and fuel consumption for fleet vehicles. Fleet vehicle data is reported using the General Services Administration (GSA) Federal Automotive Statistical Tool (FAST). The LaRC fleet manager enters data into this system. Information including fleet vehicle inventory, fuel consumption, acquisitions, and projected inventory is reported in FAST.

Since 2004, the Center has been using E-85 fuel in the flex fuel vehicles in the LaRC fleet. The LaRC fleet currently includes 25 E-85 vehicles. Use of E-85 contributes to achieving a reduction in petroleum fuel consumption and helps the Agency to increase the total fuel consumption that is non-petroleum based.

Opportunities for Program Improvement

Several opportunities exist for improving and strengthening the vehicle fleet management program at NASA LaRC including:

a. The Center could look for opportunities to maximize the use of the 25 E-85 vehicles to increase the use of alternative fuels. Some of the petroleum fueled fleet vehicles showing high annual mileage could be switched with these alternative fueled vehicles.

b. Additional LSEVs could be procured and integrated into the LaRC fleet to replace petroleum fueled fleet vehicles.

c. The LMB could purchase additional bicycles to further minimize fleet vehicle and personal vehicle use on the Center. This would save money by reducing fuel use and associated GHG emissions. Center management could initiate a Center wide outreach effort to encourage the use of the existing bicycles on Center.

## 11.6 GOAL 6: Sustainable Acquisition

**Promote sustainable acquisition by ensuring environmental performance and sustainability factors are considered to the maximum extent practicable for all applicable procurements in the planning, award and execution phases of acquisition.**

Implementation Methods and Planning Actions

The FAR Part 23 addresses sustainable acquisition policy at the Federal government level. The NASA FAR Supplement, Part 1823, addresses NASA's implementation of the FAR requirements. Additionally, NASA's Procurement Information Circular (PIC) 12-02, "Sustainable Acquisition Reporting," provides policy guidance on reporting sustainable acquisition procurements in the FPDS-NG and collecting data for reporting on NASA's sustainable acquisition performance. NPR 8530.1 also designates NASA policy on implementing sustainable acquisition. At the Center level, LaRC relies on these documents, as well as LPR 8500.1, to address sustainable acquisition requirements. NPR 8530.1 is currently undergoing an update by NASA's Environmental Management Division to incorporate updates in the agency's processes, policies, and requirements from EO 13693. Once the NPR is released, SPEEB will work with LaRC's OP to determine the impact on LaRC's sustainable acquisition procedures. Additionally, SPEEB will evaluate communication and training opportunities to inform procurement personnel of any new processes or requirements resulting from the NPR's update.

LaRC has a Sustainable Acquisition Manager in the LaRC OP who is responsible for ensuring that the applicable Federal requirements for green purchasing are being fulfilled in accordance with the FAR, NASA FAR supplement, NPR and LPR. The NASA Office of Procurement expects COs as part of their responsibilities, to be familiar with, and have sufficient knowledge of, FAR Part 23 and the various Federal environmental programs. LaRC's OP Sustainable Acquisition Manager and SPEEB assist COs with understanding these programs so they are able to place the appropriate FAR provisions and clauses in solicitations and contracts, screen procurement requirements to determine if any environmental programs apply, and record sustainable acquisition activity accurately in FPDS-NG. Due to the loss of knowledgeable procurement support personnel resulting from the planned transfer of Simplified Acquisitions to the NSSC in FY 2017, and the subsequent drop in FY 2015 3rd and 4th quarter contract review compliance rates, SPEEB plans to conduct green purchasing training for the entirety of LaRC OP. This training will include a review of the EO 13693 goals.

OP forwards statements of work and clauses of certain solicitations to SPEEB for review in order to ensure applicable environmental requirements, including sustainable acquisition, have not been overlooked. In FY 2016 and beyond, SPEEB plans to participate in more Procurement Strategy Meetings (PSMs) in order to ensure environmental requirements and sustainable practices can be included in the earliest stages of solicitation development.

LaRC's OP participates in PMRs conducted by HQ OP every three years. This review includes assessing current performance on sustainable acquisition. LaRC also conducts self-assessments as necessary in order to prepare for the PMRs. SPEEB and OP will continue to work closely to ensure an effective sustainable acquisition program at LaRC so that OP can perform well in future PMRs.

LaRC COs and purchase requisitioners utilize LF 1707, the LaRC Overprint of NF 1707, "Special Approvals and Affirmations of Requisitions" as a guide to determine applicable sustainable acquisition requirements for procurements and FPDS-NG data entry. The form is required by NASA FAR Supplement, section 1804.7301, to document procurement request coordination. For purchases under the micro-threshold level, LaRC P-Card

holders are required to identify when environmental acquisition programs apply to their purchases and if their purchases adhere to the requirements, or supply justification on their order logs if they do not.

The SPEEB promotes use of environmentally preferable products through their outreach and training programs. The Sustainable Acquisition web pages give access to information on the various Federal green purchasing programs, links to regulations and guidance, a list of items that the Center must buy with recycled/biobased content, and access to outreach documents. SPEEB will continue to update the pages with new information and outreach tools as necessary.

NASA has established a Procurement community of practice consisting of representatives from NASA HQ and Center personnel to ensure appropriate coverage of sustainable acquisition requirements. LaRC's OP Sustainable Acquisition Manager and SPEEB will continue to participate in this Procurement community of practice.

Opportunities for Program Improvement

Several opportunities exist for improving and strengthening the sustainable acquisition program at NASA LaRC including:

a. The OP, with assistance from SPEEB, could conduct procurement interviews with those Directorates and contracts that report non-compliant purchases on the annual green purchasing data call to identify their challenges and educate personnel on the requirements.

b. OP, with assistance as necessary from SPEEB, could conduct reviews of completed LF 1707s to ensure requisitioners are filling the forms out properly. This would help identify any additional training needs for Center personnel and contract specialists.

c. Contracts at LaRC already in place and in progress could be audited by OP to ensure green purchasing contract requirements are being met. Positive or negative outcomes of the reviews could be included as part of the Award Fee performance indicator or annual Performance Review of the contracts.

d. OP could perform additional pre-solicitation and pre-award reviews of applicable contract actions for sustainable acquisition.

e. Sustainable acquisition could be included as an evaluation factor during the review of solicitation responders. Contractors could be required to detail how they will use green products in performance of contracts, should they be selected.

f. SPEEB could develop an audit strategy with OP to maximize the surveillance of P-Card orders for green products. OP could also identify what repercussions they would impose for continued non-compliance.

g. An online sustainable acquisition training course could be developed and required of all new employees. Procurement personnel and contracting officers would be required to take the training on an annual basis.

## 11.7 GOAL 7: Pollution Prevention & Waste Reduction

**Divert 50% of solid waste, including food and compostable materials throughout FY 2025.**

**Divert 50% of construction and demolition debris throughout FY 2025.**

Implementation Methods and Planning Actions

Solid waste management and recycling are integral to the environmental program at NASA LaRC. Solid waste generated at the Center is collected for disposal or sent off-site to be recycled. Solid waste is comprised of items such as product packaging, miscellaneous non-recyclable scrap materials, food waste, office waste designated as trash, broken glass, and other miscellaneous trash. The LMB oversees the daily operation of collecting solid waste and SPEEB oversees the daily operation of the recycling program. A large percentage of solid waste collected at NASA LaRC is sent to the Waste to Energy Plant for energy recovery. This facility burns trash to generate steam. The steam produced is sent throughout NASA LaRC to be used as an energy source for heating and other uses.

NASA LaRC has an active recycling program. A wide variety of materials are collected for recycling including aluminum (including drink cans), copper, ferrous metals, white and mixed paper, toner cartridges, cardboard, plastic bottles, fluorescent light bulbs, batteries, and oil. C&D debris is also recycled by LaRC contractors. This material consists of the debris generated during the construction, renovation, and demolition of buildings. C&D debris often contains bulky, heavy materials, such as concrete, wood, metals, glass, and salvaged building components.

The SPEEB support contractor manages the Center's Recycling Facility, Building 1181. The facility houses a cardboard baler, paper baler, and drum crusher. Paper and cardboard are baled in order to obtain the highest possible rebate from the sale of these recyclables. The proceeds collected from the sale of recyclables at LaRC are used to fund additional recycling and pollution prevention projects. The quantities of materials recycled vary from year to year depending on workload and active projects at the Center. The recycling procedures and metrics are available for review by all Center personnel through SPEEB's website.

NASA has established a Recycling and Sustainable Acquisition (RSA) community of practice consisting of approximately 130 representatives from NASA HQ and Center Environmental, facilities, other organizations and support contractors to ensure appropriate coverage of program requirements. NASA LaRC personnel participate in this community of practice.

Opportunities for Program Improvement

Several opportunities exist for improving and strengthening the solid waste diversion and recycling program at NASA LaRC including:

a. SPEEB could provide additional recycling training to Center employees to increase collection and decrease contamination of solid waste collected for recycling. By increasing employee awareness of the environmental and economic benefits of maintaining an effective recycling program, the program could be improved.

b. Additional collection containers could be purchased and placed around the Center to make it easier and more convenient for employees to recycle. Having more recycling containers in convenient locations would likely increase employee participation in the recycling program. Increased recycling participation would require an investment in labor, containers, and transportation to accommodate the increase.

c. The SPEEB could consider expanding the recycling program by adding new items for recycling (ex. glass drink bottles, other glass waste, Styrofoam). This would involve keeping abreast of different manufacturing technologies, recycling markets, and equipment. Since these items would not result in a return in revenue, NASA would need to commit to investing in this program (labor, containers, transportation, etc.)

d. A solid waste audit could be conducted to further define LaRC's waste streams. A representative sample of dumpsters could be evaluated to generate general Center-wide solid waste stream statistics. By thoroughly understanding what is being disposed of and in what quantities, the Center can better

educate personnel and focus future recycling efforts. Also, an audit would reveal problem areas in the recycling program such as excessive cardboard being disposed of rather than recycled.

e. LaRC could determine an effective mechanism for enforcing C&D recycling on smaller projects. Large construction and demolition projects tend to have effective recycling programs in place and requirements written into their contracts. However, smaller projects such as sidewalk replacements, small upgrades, and storm damage repair often generate recyclable C&D debris that ends up being taken to a landfill. Projects of this nature may be completed by subcontractors who may not understand LaRC's recycling requirements.

## 11.8 GOAL 8: Energy Performance Contracts

**Utilize performance contracting to meet energy efficiency goals.**

Implementation Methods and Planning Actions

The Center regularly reviews potential ESPC/UESC projects and will continue to conduct feasibility studies for such projects as needed. Economic viability for ESPC/UESC contracts at LaRC is hindered by exceptionally low electricity rates. Program improvement (i.e. more projects implemented) is unlikely to occur unless rates increase.

Opportunities for Program Improvement

The Center regularly reviews potential ESPC/UESC projects and will continue to conduct feasibility studies for such projects as needed.

The 10-year ECPP planning process will include opportunities for ESPC/UESC projects to meet Energy/Water intensity reduction goals in EO 13693. Any opportunities identified will be incorporated in the FY 2017 update of this EMSP.

## 11.9 GOAL 9: Electronic Stewardship

**Procure energy-efficient equipment (rated per Energy Star, EPEAT).**

**Use best practices for computer operation and disposal.**

**Employ environmentally sound practices with respect to the disposition of excess or surplus electronic products.**

Implementation Methods and Planning Actions

NASA created Desktop Computing Standards that provide a common framework for consistent IT practices across all NASA Programs. NASA-STD-2804, Minimum Interoperability Software Suite, states that printers, laptops, and desktop systems must be configured to use energy-saving settings in order to comply with sustainability goals. NASA-STD-2805, Minimum Hardware Configurations, states that all newly procured systems must be EPEAT-registered and that all systems currently supplied are also registered. NASA has incorporated these standards in all IT procurement contracts since 2007, and they are in the current ACES contract.

LaRC personnel tasked to manage IT-based electronic assets implement configuration policies relating to improving energy efficiency and environmental stewardship of electronic assets as required in the above standards. Several energy efficient options are utilized on electronic products at LaRC, and OCIO follows the National Institute of Standards for power management for each operating system used at LaRC, with the exception of putting systems into hibernation mode when not in use. This exception allows software pushes, patches, and backups to be implemented as needed.

LaRC has standardized the use of multi-functional devices (MFDs) as the Center's primary printing devices, which are deployed across the Center based on an analysis of staffing and building configurations. LaRC's MFDs have standardized print configurations, including duplex and black and white defaults, reduced toner density, and enabled sleep mode.

The LaRC OP ensures that contracts or services that will include the use of energy-using products contain the necessary FAR clauses that require the purchase of Energy Star and other FEMP-designated products. Designs for construction projects and on-site maintenance activities specify products that meet Energy Star and/or FEMP requirements.

As part of the electronics stewardship program at LaRC, government furnished electronic products that reach end-of-life are reused, donated, sold, or recycled using environmentally sound management practices. LaRC complies with the GSA procedures for the transfer, donation, sale and recycling of electronic equipment at end of life. Equipment that is still in usable condition is transferred to other Federal agencies or donated to schools and other eligible educational organizations through donation programs managed by GSA (ex. Computers for Learning program).

Government furnished electronic equipment that is not transferred or donated is offered for sale through the GSA Auction. If the equipment does not sell through GSA, it is disposed of through an electronics recycling contract managed by GSA. Scrap electronic equipment that is not reusable is also disposed of through the electronics recycling contract.

For personal electronics, LaRC now promotes the use of USPS Blue Earth. USPS Blue Earth is a group of federal recycling programs coordinated by the US Postal Service to support sustainability initiatives that make it easy for federal agencies and their employees to properly dispose of items like empty ink cartridges and unwanted small electronics. In FY 2015, LaRC employees recycled 24 items via USPS Blue Earth.

Opportunities for Program Improvement

Opportunities exist for improving and strengthening the electronics stewardship program at NASA LaRC including:

a. Contracts at LaRC already in place and in progress could be audited by OP and OCIO to ensure EPEAT purchasing contract requirements are being met.

b. LaRC could continue pursuing aggressive computer power management policies, giving user groups the option of "intelligently managing" their electronics and software so that machines will be shut down when not in use for extended periods of time, such as weekends.

c. There are many organizations and branches at LaRC that regularly replace their electronic equipment. Evaluations could be performed to determine whether Center electronic equipment could be reused on-site before the equipment is deemed to be at end-of-life and excessed. This could extend the useful life of Agency electronic equipment. As part of this effort, an internal website could be developed which lists the electronic equipment available for reuse.

d. To minimize energy usage on electronic equipment, LaRC could use "Smart Strips" to reduce vampire energy usage. These strips help reduce the idle current drawn from outlets when electronics are not in use.

e. LaRC could review Center policy and practice regarding disposition of excess and surplus electronic products. Policy and practice should be updated where necessary to ensure sound disposition methods are employed.

f. LaRC could review Center policy and practice regarding energy efficient management of servers and data centers. Policies should be updated where necessary to ensure that these practices are leveraged wherever possible and practical.

## 11.10 GOAL 10: Climate Change Resilience

**Incorporate climate-resilient design and management into the operation, repair, and renovation of new and existing buildings.**

**Consider and prepare for the effects of climate change on operations, missions, and programs.**

Implementation Methods and Planning Actions

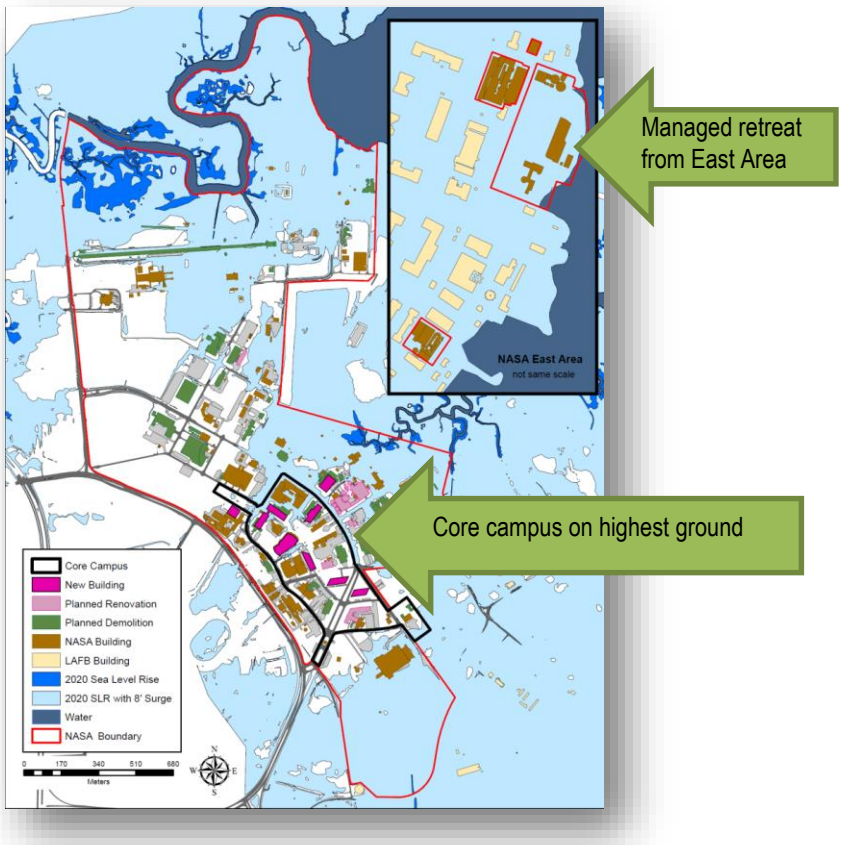
**Integration into LaRC's Master Planning.** LaRC's Master Plan incorporates adaptation strategies to address potential climate change impacts on the missions, operations, and infrastructure at the Center. Examples are shown in Table 8 below:

**Table 8 – Master Planning and Climate Adaptation Strategies**

| Climate Factor | Specific Concern | Adaptation Strategies |
|---|---|---|
| **Higher Frequency of Severe Storms (hurricanes, heavy rain, snow, etc.)** | East Area facility damage; power outages; wind damage; flooding. | Implement storm hardening projects; flood barriers; substation/utility tunnel protection; storm sewer upgrades. |
| **Storm Surge (periodic severe flooding)** | Deteriorating electrical, communication and utility systems located within flood zone. | Install corrosion resistant systems<br>Re-establish/expand riparian buffer<br>Raise critical infrastructure; site new buildings outside of flood zone. |
| **Sea Level Rise (and coastal flooding)** | Complete inundation of some buildings | Consolidate infrastructure to core area; retreat from East Area; re-establish/expand riparian buffer. |
| **Extreme Temperatures** | Power outage; increased demand on HVAC systems. | Construct energy efficient buildings; Condition Based Monitoring for critical HVAC systems. |

LaRC's Master Plan accounts for the impact of sea-level rise with the incorporation of the predicted coastal flooding models. As shown in Figure 5 on the following page, the plan includes a consolidation of infrastructure into the Core Area campus, which is the high ground of the West Area.

**Figure 5 - Projected 2020 Sea Level Rise with 8 Foot Storm Surge**




**Incorporation into the Environmental Project Planning Review Process.** In addition to reviewing LaRC's projects for environmental impacts, LaRC environmental staff include potential climate change impacts and adaptations as part of the project review process (e.g., selecting higher elevation sites for new construction, specifying more energy efficient products and systems, incorporating Low Impact Development requirements to improve stormwater runoff).

**LaRC GIS Team Support.** LaRC's GIS Team has developed a Flood Impact Analysis Tool that provides detailed facility and utility data to support storm impact studies and potential storm hardening projects at LaRC. It has also provides mapping and building-by-building analysis for inclusion into the Center's Master Plan. This tool helps decision-makers understand how best to protect existing assets as well as plan for future mitigation and adaptation strategies.

As noted in the Highlights section of Chapter 9, the LaRC GIS Team continually collaborates and partners with key stakeholders both locally and on a national level to provide highly useful information, data, and tools for climate change preparedness and resilience.

Opportunities for Program Improvement

Several opportunities exist for improving and strengthening the climate change resilience program at NASA LaRC including:

a. LaRC managers could revisit the adaptation measures and strategies that were drafted during the 2011 Resilience and Adaptation to Climate Risks Workshop. Each of the three systems groups (Built Systems, Natural Resource Systems, and People/Community Systems) developed ideas for mitigating the near and long term effects of climate change and sea level rise at LaRC. Many of these strategies have been implemented or incorporated into broader initiatives that LaRC is pursuing. Others may have been “put on the back burner” and could warrant a fresh evaluation.

b. LaRC could host another Climate Adaptation workshop that would take into account recent changes to the Center’s infrastructure, mission, and operations; the latest technology and models for sea level rise and local flooding/storm predictions; and lessons learned from the Agency-wide Climate Change Resilience workshops and initiatives.

# 12 APPENDIX A - ACRONYMS AND ABBREVIATIONS

**ACES** Agency Consolidated End-User Services
**AFV** Alternative Fueled Vehicle
**BTU** British thermal unit
**C&D** Construction and Demolition
**CEQ** Council on Environmental Quality
**CIO** Chief Information Officer
**CMOE** Center Maintenance Operations and Engineering
**CNG** Compressed Natural Gas
**CO** Contracting Officer
**COD** Center Operations Directorate
**CPG** Comprehensive Procurement Guidelines
**CRF** Computational Research Facility
**CSO** Center Sustainability Officer
**DOT** Department of Transportation
**ECPP** Energy Conservation Performance Plan
**EEP** Energy Efficiency Panel
**EET** Energy Efficiency Team
**EISA** Energy Independence and Security Act of 2007
**EMCS** Energy Management Control System
**EMS** Environmental Management System
**EMSP** Environmental Management and Sustainability Plan
**EO** Executive Order
**EPA** Environmental Protection Agency
**EPAct** Energy Policy Act of 2005
**EPEAT** Electronic Product Environmental Assessment Tool
**ESPC** Energy Savings Performance Contract
**FAR** Federal Acquisition Regulation
**FAST** Federal Automotive Statistical Tool
**FC** Facility Coordinator
**FEC** Facility Environmental Coordinator
**FEMP** Federal Energy Management Program
**FPDS-NG** Federal Procurement Data System – Next Generation
**FSH** Facility Safety Head
**FY** Fiscal Year
**GHG** greenhouse gas
**GIS** Geographic Information Systems
**GSA** General Services Administration
**GSF** Gross Square Foot
**HQ** Headquarters
**HRSD** Hampton Road Sanitation District
**HVAC** Heating, Ventilating and Air Conditioning
**IESB** Integrated Engineering Services Building
**IT** Information Technology
**kW** kilowatt
**kWh** kilowatt hour
**LAPD** Langley Policy Directive
**LaRC** Langley Research Center
**LEED** Leadership in Energy and Environmental Design
**LEED-NC** LEED certification program for New Construction
**LITES** Langley Information Technology Enhanced Services
**LMB** Logistics Management Branch
**LPR** Langley Procedural Requirement
**LSEV** Low Speed Electric Vehicle
**MFD** Multi-Function Device

**MSL** Measurements Systems Laboratory
**MtCO2e** Metric Tons of Carbon Dioxide Equivalent
**MW** Megawatt
**MWh** Megawatt hours
**NASA** National Aeronautics and Space Administration
**NETS** NASA Environmental Tracking System
**NPD** NASA Policy Directive
**NPR** NASA Procedural Requirement
**NREL** National Renewable Energy Laboratory
**NSSC** NASA Shared Services Center
**NZEB** net zero energy building
**OCIO** Office of the Chief Information Officer
**OMB** Office of Management and Budget
**OP** Office of Procurement
**OUM** Organizational Unit Manager
**PIC** Procurement Information Circular
**PMR** Procurement Management Review
**PMS** Procurement Strategy Meeting
**PUE** Power Usage Effectiveness
**PV** Photovoltaic
**REC** Renewable Energy Credit
**RRAC** Regulatory Risk Analysis and Communication (Principal Center)
**RSA** Recycling and Sustainable Acquisition (Principal Center)
**SATERN** System for Administration, Training, and Educational Resources
**sf** square feet or square foot
**SNAP** Significant New Alternatives Policy
**SPEEB** Standard Practice and Environmental Engineering Branch
**SREC** Solar Renewable Energy Certificate
**SSPP** Strategic Sustainability Performance Plan
**TDT** Transonic Dynamic Tunnel
**UESC** Utility Energy Service Contract
**USDA** US Department of Agriculture