NASA Langley Research Center

Environmental Management and Sustainability Plan

2022 Update

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NASA LaRC Environmental Management and Sustainability Plan

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Introduction

Agency Sustainability

The National Aeronautics and Space Administration (NASA) publishes a Sustainability Report and Implementation Plan (SRIP) 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 (EOs). In January 2021, EO 13834, *Efficient Federal Operations* was revoked by EO 13990, *Protecting Public Health and the Environment and Restoring Science To Tackle the Climate Crisis*. EO 13990 did not set replacement sustainability goals for those it revoked and an EO setting new goals, baselines, and implementation instructions was not released in FY 2021. In the interim, per guidance received by the Council of Environmental Quality (CEQ), agencies continued sustainability strategies and actions based on the former EO 13834 goals.

In the first quarter of FY 2022, EO 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability* was released, along with an accompanying Federal Sustainability Plan. The EO lays out a coordinated, whole-of-government approach to transform Federal procurement and operations and secure a transition to clean energy and sustainable technologies. CEQ will issue Implementing Instructions that will provide directions, strategies, and recommended actions to comply with the EO, and as necessary, additional guidance on meeting EO goals and requirements. Agencies will then be expected to propose specific targets to CEQ and the Office of Management and Budget (OMB) for their review and approval. Goals and targets under the EO will include greenhouse gas emission reductions, transitioning to pollution-free electricity, transitioning to a zero-emission fleet, net-zero emissions buildings, increasing energy and water efficiency, integrating advanced sustainability in Federal buildings, and sustainable acquisition and procurement throughout the supply chain.

NASA's sustainability policy is:

To execute NASA's mission without compromising our planet's resources so that future generations can meet their needs. In its SRIP, NASA commits to advancing efficiency and sustainability in Agency operations, meeting or exceeding goals and requirements, and achieving cost savings.

In implementing sustainability practices, NASA uses proactive measures to reduce NASA's environmental, institutional, programmatic, and operational risks. In doing so, the Agency continuously improves the resilience of its space and ground asset operations and performance. To this end, NASA seeks to be pragmatic 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 executing its mission, the NASA Langley Research Center (LaRC) adopted the sustainability policy and NASA sustainability goals from the Agency SRIP, which consisted of the following program areas:

- Facility Energy Efficiency
- Efficiency Measures, Investment, and Performance Contracting
- Renewable Energy
- Water Efficiency
- High Performance Sustainable Buildings
- Waste Management and Diversion
- Fleet Management
- Sustainable Acquisition
- Electronics Stewardship
- Greenhouse Gas Emissions

LaRC's Environmental Management and Sustainability Plan (EMSP) serves as the Center's documentation of progress toward goals outlined in the NASA SRIP. The Center Sustainability Officer (CSO) oversees the plan's

implementation. This position is 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 Environmental Management Office (EMO).

The EMSP provides a record of LaRC's commitment to, and contributions toward, the goals and requirements of the NASA SRIP, as well as documentation of potential program improvements. Each of the EMSP chapters are comprised of the following subsections:

- **Goal Description** provides the applicable EO goals and requirements from the 2020 SRIP.
- **Center Status** provides a status update on LaRC's FY 2020 progress in meeting Agency and Center goals and objectives in each program area.
- **Highlights** provides a description of LaRC's recent achievements and successes in each program area.
- **Implementation Methods** identifies ongoing 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 below provides a summary of LaRC's EMSP goals for FY 2021 and a visual status indicator (stoplight) to identify if the goal was met (green), not fully met but a plan is in place for improvement (yellow), or not being met and no plan to meet the goal is anticipated (red).

LaRC's goals for FY 2022 will be based on the specific targets set by EO 14057 and NASA's corresponding implementation strategy, which at the time of completion of this document, are still pending.

Table 1 – Goal Summary

GOAL SUMMARY

Goal 1: Facility Energy Efficiency

Achieve 30% reduction in BTU/GSF relative to fiscal year (FY) 2003 and 1% reduction in FY 2021 relative to FY 2020.

Goal 2: Efficiency Measures, Investment, and Performance Contracting

Utilize performance contracting to achieve energy, water, building modernization, infrastructure goals.

Goal 3: Renewable Energy

At least 7.5% of total electricity consumed from renewable sources.

Goal 4: Water Efficiency

Achieve 20% reduction in gal/GSF relative to FY 2007 and 0.5% reduction in FY 2021 relative to FY 2020.

Goal 5: High Performance Sustainable Buildings

At least 15% of agency owned buildings or GSF qualify as sustainable and demonstrate annual progress.

Goal 6: Waste Management and Diversion

Send less than 50% non-construction non-hazardous solid waste and construction and demolition waste to treatment and disposal facilities.

Goal 7: Transportation / Fleet Management

Achieve 20% reduction in petroleum fuel use relative to FY 2005 and 0% reduction in FY 2021 relative to FY 2020.

Goal 8: Sustainable Acquisition

Increase in the percentage of agency contract actions and increase in percentage of obligations (in dollars) containing statutory environmental requirements.

Goal 9: Electronic Stewardship

Continuous improvement to ensure sustainable electronics management: Newly purchased or leased equipment meets energy efficiency requirements; Equipment has power management enabled (excluding exempted equipment); Electronic equipment disposed using environmentally sound methods.

Goal 10: Greenhouse Gas (GHG) Emissions

Reduce agency Scope 1 and 2 emissions compared to 2008.

1 Goal: Facility Energy Efficiency

1.1 Goal Description

Achieve 30% reduction in BTU/GSF relative to FY 2003 and 1% reduction in FY 2021 relative to FY 2020.

1.2 Center Status

- 39.6% reduction in BTU/GSF relative to FY 2003.
- 2.2% reduction relative to FY 2020.

Energy conservation efforts at Federal facilities are tracked according to the guidelines established in the Energy Policy Act 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.

Table 2 below shows LaRC's total energy consumption over the past several years relative to FY 2003. LaRC's FY 2021 total energy usage for all facilities was 850,140 Million BTU (MMBTU) - an overall 29% usage decrease from FY 2003 (1,195,522 MMBTU), and a 9.5% decrease from FY 2020 (939,608 MMBTU).

Goal Subject energy consumption for FY 2021 was 174,093 MMBTU, a 42% decrease in Goal Subject energy consumption from FY 2003.

			Luito Liicigy	consumption		
	FY 2003	FY 2018	FY 2019	FY 2020	FY 2021	% Reduction
Goal Excluded	895,554	658,541	726,804	760,945	676,047	24.5
Goal Subject	299,968	195,781	186,640	178,663	174,093	42.0
Total	1,195,522	854,322	913,444	939,608	850,140	28.9

Table 2 – LaRC Energy Consumption

NASA tracks energy goals by Goal Subject Energy Use Intensity (EUI), which is the annual energy consumption for Goal Subject buildings divided by the Gross Square Footage (GSF) of those facilities. For FY 2003, the EUI for Goal Subject buildings was 126,007 BTU/GSF, which is the baseline for reduction goals under EO 13834. The Goal Subject EUI for FY 2021 was 76,092 BTU/GSF, which represents a 39.6% decrease in EUI for Goal Subject buildings from the goal baseline, and a 2.2% reduction compared to FY 2020. The data in Table 3 and Figure 1 show LaRC's progress towards achieving the goal of reducing EUI.

Table 3 – LaRC Goal Subject Energy Intensity (BTU/GSF)

	DTU	005	
	BIU	GSF	EUI
FY 2003	299,968,000,000	2,380,758	126,007
FY 2018	195,780,530,000	2,342,364	84,059
FY 2019	186,640,320,000	2,352,506	79,337
FY 2020	178,662,900,000	2,295,165	77,843
FY 2021	174,092,570,000	2,287,921	76,092
Total:			-39.61%



Figure 1 – Energy Use Intensity Reduction at LaRC

1.3 Highlights

- Scope of work solicited to execute phase I of system integration of existing facility, energy/utility, and asset management applications into OSI PI and GIS. This integration will ultimately provide for the capability for advanced analytics and reporting for facility operations and performance.
- Installed heatless air dryer in B1215 central steam plant to improve energy efficiency of central plant compressed air system.
- Planned/Installed more efficient lighting/controls within multiple buildings (6) across LaRC.
- Implemented additional HVAC controls optimization for B2103 data center, kept power usage effectiveness below 1.5.
- Construction of the Measurement Systems Laboratory was completed in 2021. Possible contributions to energy reduction from this project will be evaluated.

Training and outreach continued to be a core component of energy management at LaRC in 2021, including the following activities:

- Continued recognition of Center employees who identify energy conservation measures (ECMs) or who are strong advocates for energy conservation. Since Center employees are intimately familiar with the processes and equipment in their facilities, they can identify project opportunities of which LaRC Energy Program staff may not be aware.
- EMO staff trained Facility Coordinators (FCs) and Facility Environmental Coordinators (FECs) in facility energy management through EMO's annual FEC training and FC/FSH (Facility Safety Head) meetings.
- The EMO held a successful virtual Energy Action Month, which included a virtual "expo" with links to various local and national energy and sustainability organizations and online tours, and "Working from Home Energy Efficiency" webinars for LaRC personnel presented by the EMO.
- LaRC Energy Program staff attended the virtual Annual Department of Energy (DOE) Energy Exchange conference, as well as the annual meeting of the NASA Energy Efficiency Panel (EEP), the community of practice for NASA Center energy management personnel across the Agency.

1.4 Implementation Methods and Planning Actions

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

LaRC has baselined its energy and water conservation program into the ISO 50001 Ready Navigator system. NASA intends to use the ISO 50001 Energy Management System approach to streamline energy and water program management across the agency. ISO 50001 provides an overarching system for collecting, analyzing, and communicating energy and water use data to continually improve performance and sustain energy and water and cost savings.

LaRC's Energy Efficiency Team (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.

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

On a quarterly basis, energy use intensity is reported in the NASA Environmental Tracking System (NETS) for tracking progress towards achievement of energy reduction goals. Additionally, LaRC enters monthly energy consumption data for each Goal Subject building into the DOE's ENERGY STAR Portfolio Manager tool which provides benchmarking capability and ensures compliance with Section 432 of the Energy Independence and Security Act of 2007.

In FY 2020, Energy and Water Consumption was identified as a high priority Environmental Management System (EMS) aspect. It was identified as a high priority EMS aspect again in FY 2021 with the objective to further reduce energy consumption to meet Agency energy efficiency goals.

Other reductions in energy usage are expected as older buildings are demolished and 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 and projects detailed below:

• Complete repairs and implement ECMs identified in retro-commissioning projects.

- Identify ECMs in Goal Excluded facilities and continue to identify ECMs in Goal Subject facilities through annual energy and water audits, and walkthrough audits during off-peak hours.
- Continue the small energy project funding process across the Center.
- Continue implementing HVAC control setpoint/setback optimal starts in facilities to improve building performance.
- Implement pilot-phase installations of phase change material in two LaRC buildings.
- Evaluate application and implementation of ASHRAE Guideline 36 to improve HVAC systems performance.
- Continue with system integration of facility, energy/utility, and asset management systems through OSI PI and GIS. Develop capability for advanced analytics and reporting for facility operations and performance.

Due to EO 14057, LaRC anticipates completely new energy reduction and management goals for FY 2022. In addition to clean energy requirements (see Goal 3 for more information), agencies will set energy and water use intensity reduction goals for 2030 along with annual reduction targets. The guidance and methodologies for setting these goals have yet to be prescribed. Additional energy efficiency implementation strategies for LaRC to achieve the Center's energy reduction goals will be driven by the EO and associated implementation guidance.

1.5 Opportunities for Program Improvement

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

- a. Improving the energy efficiency of the service compressed air system at B1215 and renovating the piping and insulation at B1241 (LN2 Plant) would reduce the energy consumption in this building (see Figure 2 below). Also, by re-sizing one of the air compressors and replacing the electric air dryer system, air system power demand could be reduced by almost half. However, Center-wide demand could be further evaluated, including potential power demand reduction through a leak repair and prevention program.
- b. Implementing a mandatory energy awareness training program for Center employees. The training program would emphasize Federal energy reduction goals and highlights of the various prescribing documents. 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.

LaRC Energy Program staff are continuing with program priorities identified during their strategic planning session conducted in FY 2017. Strategic planning and progress focused on these objectives continues:

- a. Maintain tight control of building energy consumption. This requires real-time building energy monitoring and analysis (tech dependent) and requires skilled, trained personnel to develop, troubleshoot, maintain, and monitor systems, analyze and act on data.
- b. Design/rehab facilities/systems to maximum energy efficiency. LaRC's energy efficient design capability has improved dramatically since beginning of the LaRC's revitalization program. Continue to focus on basics (specifying energy efficient equipment at all levels of investment; energy efficiency considered in all design/construction projects).
- c. Optimize Goal Excluded mission/mission support processes/operations for energy efficiency.

d. Foster a Center-wide culture of energy conservation. Use technology to educate (dashboards, daily updates). Use data to direct outreach (focus where it matters the most). Use data to empower (building level data drives building level behavior).



e. Institutionalize all the above and collaborate broadly across organizations.

Figure 2 – Top Ten Buildings by Electricity Usage in FY 2021

2 Goal: Efficiency Measures, Investment, and Performance Contracting

2.1 Goal Description (Agency Goal)

For Agency, utilize performance contracting to achieve energy, water, building modernization, infrastructure goals.

2.2 Center Status

HQ expects each Center to pursue every feasible opportunity to engage in Energy Savings Performance Contracts (ESPCs) or Utility Energy Service Contracts (UESCs), and each Center is required to annually submit its plans for these contracts, including project scopes and funding levels. In FY 2018 and 2019, LaRC participated in the Preliminary Assessment phase of a potential joint ESPC with neighboring Joint Base Langley Eustis. However, the Center did not feel any of the identified projects were worth pursuing through the contract and therefore withdrew and did not continue into the investment grade audit phase.

2.3 Highlights

None for FY 2021.

2.4 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 currently hindered by exceptionally low electricity rates. Program improvement (i.e. more projects implemented) is unlikely to occur unless rates increase.

To meet the clean energy usage goals set by EO 14057 (see Goal 3 for more information), the Federal Sustainability Plan identifies agency partnerships and strategic procurements as key goal actions, including aggregating carbon pollution-free electricity (CFE) purchases across regions and agencies, entering into power purchase agreements, and developing public and private sector partnerships. LaRC's participation in these types of agreements, as well as specific procurement and investment strategies to achieve the Center's future energy conservation goals, will ultimately be driven by the EO implementation guidance and NASA HQ.

2.5 Opportunities for Program Improvement

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

3 Goal: Renewable Energy

3.1 Goal Description

At least 7.5% of total electricity consumed from renewable sources.

3.2 Center Status

LaRC primarily met renewable energy requirements in the past through the purchase of Renewable Energy Credits (RECs). Since FY 2020, renewable energy targets were handled as an Agency-level goal and RECs were purchased by HQ to ensure effective costs management of the resource across all Centers.

Figure 3 shows the renewable energy generated from LaRC onsite solar photovoltaic (PV) systems. LaRC registered its solar PV systems in the Pennsylvania REC market in FY 2012 in anticipation of possible future opportunities to sell or trade those RECs for the benefit of the Center. The Center will continue its efforts to realize the economic benefit of these RECs and provide recommendations to the Agency as requested.



Figure 3 – Renewable Energy from Solar at LaRC

3.3 Highlights

None for FY 2021.

3.4 Implementation Methods and Planning Actions

LaRC primarily meets Federal renewable energy requirements through the purchase of RECs, which are managed by HQ.

LaRC's onsite renewable energy production capacity includes the 39.5 kilowatt (kW) solar array behind B1308, the Center's Badge and Pass Office, a 22 kW solar roof array and a 1.5 kW thin film skylight in B2101. These three systems produced about 56.2 MWh in FY 2021.

LaRC's onsite renewable energy production capacity also includes two operational ground source heat pump systems for building heating and cooling (B2101 and B2102). At this time neither system is included in LaRC's renewable energy calculations.

LaRC anticipates completely new clean/renewable energy usage and management goals for FY 2022 due to EO 14057. The EO sets an aggressive goal for the Federal Government to achieve 100% CFE use by 2030, including 50% on a 24/7 basis. This means purchasing electricity produced from resources that generate no carbon emissions, including solar and wind, for all its operations. The ability to meet this goal will ultimately depend on the utility industry's ability to provide CFE for agencies to procure. Additional energy generation and usage strategies for LaRC to achieve specific clean energy goals will be influenced by the EO, associated EO implementation guidance, and HQ.

3.5 Opportunities for Program Improvement

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

- a. Evaluating additional renewable energy generation projects, such as installation of a new solar PV system. LaRC continues to investigate opportunities for implementing renewable energy projects at the Center.
- b. Pursuing research projects at LaRC that involve new energy technologies, such as wind power.

4 Goal: Water Efficiency

4.1 Goal Description

Achieve 20% reduction in gal/GSF relative to FY 2007 and 0.5% reduction in FY 2021 relative to FY 2020.

4.2 Center Status

- 41.5% reduction in gal/GSF relative to FY 2007.
- 20.2% reduction relative to FY 2020.

The data in Figure 4 shows LaRC's progress towards achieving the goal of reducing water consumption intensity. At the end of FY 2021, LaRC's water consumption intensity (20.5 gal/GSF) was reduced by 41.5% relative to the FY 2007 baseline (35.1 gal/GSF), exceeding the 20% reduction required from the baseline. The 20.2% reduction between FY 2020 (25.7 gal/GSF) and FY 2021 exceeded the 0.5% annual reduction goal.

Year	Water Use Intensity (Gal/GSF)
FY 2007 (Baseline)	35.1
FY 2018	26.0
FY 2019	25.2
FY 2020	25.7
FY 2021	20.5

Table 4 – Annual Water Use Intensity Reduction at LaRC (gal/GSF)



Figure 4 – Water Use Intensity Reduction at LaRC (gal/GSF)

The Center continues to pursue ways to identify leaks and operational problems more quickly, including advocating for the installation of digital water meters. Additionally, since high levels of water consumption at cooling towers comes from water blowdown, EMO is working to identify and implement projects to address and reduce the amount of and need for water blowdown. While Center operations improvements, conservation, and leak detection help to reduce water intensity on Center, LaRC's demolition plans may affect the ability of the Center to meet annual reduction goals in the future as these 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 currently projected to drop significantly, since there is not a concurrent reduction in personnel and research operations. Additional investment in water consumption reduction projects will likely be required.

4.3 Highlights

- The Potable Water Phase II project was completed, making various improvements to potable water infrastructure and installation of water meters for monitoring purposes. The project included the replacement of 149 water valves and older cast-iron piping, as well as the installation of flow meters in 72 locations around LaRC.
- YET2 technology scouting company evaluated emerging cooling-tower water conservation technologies (reducing cooling tower blowdown and thus reduced water consumption at the chosen cooling tower). LaRC has selected preferred technology for pilot project implementation.

Training and outreach continued to be an important component of energy and water management at LaRC in FY 2021, including the following activities:

• EMO staff trained FCs and FECs in facility energy and water management through EMO's annual FEC training.

4.4 Implementation Methods and Planning Actions

The Center's Energy Manager is 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.

Real-time monitoring of sanitary sewer discharge measurements is now available through the OSIsoft PI system that was originally developed for the Center's condition-based maintenance initiative, and it presents opportunities to quickly identify leaks that discharge to that system.

LaRC's EET also supports water conservation communication and project implementation across LaRC.

Energy and Water Consumption was identified as a high priority EMS aspect in FY 2020 with the objective to reduce water consumption by 0.5% annually. Selection as a high priority aspect allows the EMS to focus resources and management attention on addressing the aspect's identified objectives and targets, as selected by the Center's EMC. It was identified as a high priority EMS aspect again in FY 2021 with the objective to further reduce water consumption.

Other water conservation projects will continue to be implemented in support of reducing water consumption intensity. To reduce water consumption and to continue to achieve water reduction goals, several specific strategies and projects are being pursued, as detailed below:

- Continue to advocate for funding to install additional metering on major cooling towers.
- Continue the small energy and water project funding process.
- Continue to use sanitary sewer metering to identify water consumption and discharge anomalies more efficiently.
- Evaluate preventative maintenance operations of cooling towers and identify opportunities to reduce water consumption across the Center.
- Continue identification of potential water conservation projects through facility energy and water audits.
- Continue the Center-wide assessment of Energy Management Control System HVAC run schedules and controls.
- Review new operations and construction projects for water conservation opportunities.
- Pilot project implementation of technology selected during YET2 evaluation process.

LaRC anticipates new water reduction and management goals for FY 2022 due to EO 14057. The EO directs agencies to set energy and water use intensity reduction goals for 2030 along with annual reduction targets. The guidance and methodologies for setting these goals have yet to be prescribed. Additional specific water conservation strategies for LaRC to achieve the Center's future water use reduction goals will be driven by the EO implementation guidance and NASA HQ.

4.5 **Opportunities for Program Improvement**

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

- a. Installing advanced meters on cooling towers. Cooling towers are major water users on Center, with leaks, valve malfunctions, and other issues, causing unnecessary water loss each year.
- b. Implementing a mandatory water conservation training program for Center employees. The training program would highlight Federal water reduction goals and the various prescribing documents. The program could be web-based and administered through SATERN. Increasing employee awareness would support achievement of water reduction goals.
- c. Evaluating additional LaRC 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. Establishing a Water Conservation Awards program 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.

5 Goal: High Performance Sustainable Buildings

5.1 Goal Description

At least 15% of agency owned buildings or GSF qualify as sustainable and demonstrate annual progress.

According to NASA's SRIP, the annual goals for sustainable buildings are:

Goal for FY 2020: 20.6% number of buildings (bldgs) and 24.8% gross square feet (GSF) **Progress for FY 2020:** 21.6% (bldgs) and 25.8% (GSF) **Goal for FY 2021:** 22.6% (bldgs) and 26.8% (GSF)

NASA HQ has not assigned LaRC a Center-level goal, however, the Center's continued implementation of its comprehensive 20-year revitalization program is expected to assist LaRC in increasing its percentage of sustainable buildings.

5.2 Center Status

- 7.4% of total GSF qualified as sustainable in FY 2021.
- No change in GSF qualified as sustainable compared to FY 2020.

5.3 Highlights

• Construction on the 175,000 square foot Measurements Systems Laboratory (B2104) was substantially complete at the beginning of FY 2021; however, issues with deficiencies in major building systems has delayed occupancy, with move-ins expected in the spring of FY 2022. The building achieved Leadership in Energy and Environmental Design (LEED)-New Construction (NC) Gold certification.

5.4 Implementation Methods and Planned Actions

NASA has adopted LEED as its performance measure for sustainable development and has mandated a minimum LEED Silver rating for all new construction and major renovation projects. The Facilities Engineering and Real Property Division at HQ provides guidance on sustainable facilities design and construction and periodically assesses progress of the sustainable design program at each of the NASA Centers. Additionally, NASA Procedural Requirement (NPR) 8820.2G, Facility Project Requirements includes project funding requirements and requirements for NASA High Performance Buildings, including utility management strategies and other facility project processes.

LaRC's Engineering Standards include specific requirements for sustainable facility projects and are regularly reviewed and updated by EMO staff. LaRC's Strategic Infrastructure Transformation Office ensures that high performance sustainable design and green building strategies are incorporated into the Center's Master Plan and EMO coordinates with Project Managers to ensure sustainable strategies are incorporated into project design plans.

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

In FY 2022, Buildings 1194, 1194A and 1200 will be demolished which will result in a reduction of LaRC's GSF by 78,171 square feet and an increase in the percentage of the Center's sustainable buildings.

Due to EO 14057, stringent new goals for sustainable facilities are anticipated for NASA for FY 2022 and beyond. The EO sets an ambitious goal for the entire Federal Government of achieving net-zero emissions buildings by 2045, including 50% reduction by 2032. Additionally, all new construction and major modernization projects larger than 25,000 GSF entering the planning stage will be required to be designed, constructed, and operated to be net-zero emissions by 2030, and where feasible, net-zero water and waste. The Federal Sustainability Plan instructs agencies to prioritize building electrification and complete deep energy retrofts and whole building commissioning.

Additional strategies for NASA (and LaRC) to achieve these goals will be driven by the EO, associated EO implementation guidance, and the Federal Building Performance Standards in development by CEQ.

5.5 Opportunities for Program Improvement

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

- a. Ensuring that LaRC's sustainable design program and associated requirements (e.g., Engineering Standards) are consistent with NPR 8820.G, Facility Project Requirements.
- a. Implementing a robust training program to disseminate sustainable design and green building information to key Center personnel involved in facility and project planning and design.
- b. Expanding collaboration with local and regional entities regarding strategies for future sustainable development and to address challenges associated with future climate change impacts.
- c. Considering 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-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.

6 Goal: Waste Management and Diversion

6.1 Goal Description

Send less than 50% non-construction non-hazardous solid waste and construction and demolition (C&D) waste to treatment and disposal facilities. Achieve 1% reduction in non-hazardous solid waste generated in FY 2021 relative to FY 2020.

6.2 Center Status

Solid Waste Diversion (Excluding C&D Debris)

- 605 metric tons of non-hazardous solid waste generated (excluding C&D) in FY 2021.
- 18% sent to treatment and disposal facilities in FY2021.
- 6% reduction in generation relative to FY 2020.

In FY 2021, LaRC landfilled 220,340 pounds (110 metric tons) and diverted 1,356,417 pounds (678 metric tons) of non-hazardous solid waste. LaRC diverted 86% of its total non-C&D non-hazardous solid waste in FY 2021, which is an increase of 10% from FY 2020. Table 5 shows FY 2021's diversion data by the type of diversion utilized. Table 6 expands on the type of materials recycled in recent years.

Table 5 – FY 2021 Center Landfill, Waste-to-Energy Steam Plant, and Recycling Data

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	Landfilled	Waste-to-Energy	Recycled	Diverted Yard	
	(lbs.)	Steam Plant (lbs.)	(lbs.)	Debris (lbs.)	
	220,340	556,960	434,057	365,400	

Table 6 – Recycling of Non-Hazardous Solid Waste (Excluding C&D Debris) (FY 2017-21)

		ina maete (
Type of Material	FY 2017 (lbs.)	FY 2018 (lbs.)	FY 2019 (lbs.)	FY 2020 (lbs.)	FY 2021 (lbs.)
Aluminum	4,020	11,532	1,340	0	0
Batteries	7,204	17,993	4,265	9,548	4,318
Cardboard	63,880	71,580	62,000	43,140	34,560
Copper (incl. copper wire)	0	0	0	0	0
Ferrous Metals	360,104	444,423	518,390	178,040	364,800
Fluorescent Lighting Tubes	3,092	2,795	3,772	2,182	2,926
Mixed Paper	40,540	63,860	42,980	35,740	23,300
Toner Cartridges	1,322	974	644	179	21
Used Oil	0	39,607	30,042	0	0
White Paper	38,700	39,580	24,040	9,760	0
Plastic Bottles	6,658	7,575	9,155	5,232	4,132
Total	637,755	699,919	696,628	283,821	434,057

C&D Debris Diversion

- 63.28 metric tons of C&D debris generated in FY 2021.
- 46% sent to treatment and disposal facilities.

In FY 2021, a total of 126,550 pounds (63,28 metric tons) of C&D debris was generated. Of that amount, 58,800 pounds (29.40 metric tons) were sent to local landfills, and 67,750 pounds (33.88 metric tons) were recycled and/or reused. As such, 46% of C&D debris was sent to treatment and disposal facilities in FY 2021. This is a 46% increase from FY 2020 in which 0% of the C&D debris generated was sent to treatment and disposal facilities. Reported C&D recycling quantities in recent years are shown in the table below.

Table 7 – C&D Debris Recycling at LaRC (FY 2017-21)					
FY 2017 FY 2018 FY 2019 FY 2020 FY 2021					
C&D Debris (lbs.)	6,723,410	41,690	4,272,520	87,609	67,750

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Highlights 6.3

In observance of Energy Action Month and Earth Day/Arbor Day, LaRC worked with the York/Poquoson Master Gardeners to recycle plastic bags and film packaging. 12 lbs. of plastic bags and film were collected and recycled. Since the start of LaRC's biannual collection efforts in FY 2016, LaRC has collected and recycled a total of 1,471 pounds of plastic bags and film packaging.

6.4 **Implementation Methods and Planning Actions**

A large percentage of solid waste collected at LaRC is sent to the Waste-to-Energy Facility, which burns trash to generate steam that is used as an energy source for heating and other uses at LaRC. The burning of trash for energy recovery keeps it out of local landfills.

The Center's recycling program includes a wide variety of materials such as scrap metal, white and mixed paper, toner cartridges, cardboard, plastic bottles, fluorescent light bulbs, batteries, and oil. The proceeds collected from the sale of recyclables at LaRC are used to fund additional recycling and pollution prevention projects.

LaRC's environmental specifications for the construction, demolition, or rehabilitation of facilities require the recycling of debris material to the maximum extent practicable. LaRC reports its annual waste generation and disposition rates in NETS.

LaRC also participates in NASA's Recycling and Sustainable Acquisition (RSA) Community of Practice (CoP) to collaborate with other Centers in support of initiatives to improve solid waste diversion efforts.

As part of EO 14057's net-zero emissions buildings goal, the EO directs agencies to divert at least 50 percent of non-hazardous solid waste, including food and compostable material, and construction and demolition waste and debris by 2025, and 75 percent by 2030. Additionally, agencies must pursue net-zero waste buildings, where feasible. It is unknown at this time if specific diversion targets or annual reduction targets will be identified for agencies. Additional strategies for LaRC to achieve the Center's waste reduction and diversion goals will be driven by the EO implementation guidance and HQ.

6.5 **Opportunities for Program Improvement**

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

a. Additional collection containers could be purchased and placed around the Center to make it more convenient for employees to participate in recycling efforts. More collection points would, however, require an investment in labor, supplies, and transportation to ensure timely pick-ups to maintain clean facilities.

- b. The Logistic Management Office could add items to the current collection list (e.g., glass drink bottles, other glass waste, Styrofoam). This would require staying abreast of different manufacturing technologies, recycling markets, and equipment. Glass collection would also require additional safety considerations. 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.).
- c. Representative samples of LaRC dumpsters could be evaluated by means of a solid waste audit to generate Center-wide statistics. By gathering physical evidence of disposed items and their quantities, the Center would be better equipped to educate personnel and focus their recycling efforts on potential problem areas that were discovered through the audit (i.e. excessive cardboard being disposed of rather than recycled, etc.).
- d. LaRC could establish a mechanism for enforcing C&D recycling on small projects. Large C&D projects have effective recycling programs written into their contracts. However, smaller projects such as sidewalk replacements or storm damage repair often generate recyclable C&D debris that gets taken to a landfill. Projects of this nature are most often completed by subcontractors who do not understand LaRC's recycling requirements.

7 Goal: Transportation and Fleet Management

7.1 Goal Description

Achieve 20% reduction in petroleum fuel use relative to FY 2005 and 0% reduction in FY 2021 relative to FY 2020.

7.2 Center Status:

- 66% reduction in NASA fleet vehicle petroleum fuel use relative to FY 2005.
- 1.7% reduction relative to FY 2020.

LaRC fuel consumption is tracked by the LaRC Transportation Manager and the above metrics include only Federal fleet vehicles. Figure 5, below, shows all fuel dispensed at the B1199 Vehicle Maintenance Shop. B1199 supplies NASA fleet vehicles, NASA non-fleet vehicles (such as NASA-owned security vehicles), and support contractor vehicles. The upper line in Figure 5 shows total fuel dispensed. Diesel fuel and E-85 fuel ethanol must be converted to gasoline gallon equivalents (GGE) to add correctly. The conversion factors were set by the Energy Policy Act of 2005: diesel gallons multiplied by 1.155 equals GGE, and E-85 gallons multiplied by 0.743 equals GGE.



Figure 5 – Fuel Dispensed at B1199

7.3 Highlights

None for FY 2021.

7.4 Implementation Methods and Planning Actions

The Logistics Management Office (LMO) manages the LaRC fleet in accordance with Agency policies to control the number of vehicles and operating cost. An annual review maintains a fair assignment of vehicles among various mission requirements. Fleet vehicles are for use on Center and within a 50-mile radius. The LMO tracks fleet vehicle mileage and fuel use for Agency metrics. In FY 2021, LaRC had a total fleet of 108 vehicles, with 42 alternative fueled vehicles that include 29 using E-85 fuel, one hybrid electric vehicle, and twelve low speed electric vehicles (LSEVs).

LaRC is currently in the planning stage to install its first Level II electric vehicle charging stations on Center. As funding allows, the LMO will add electric vehicles to the current LaRC fleet. NASA continues to review policies to authorize privately-owned vehicle use of Federal electric vehicle supply equipment; however, such policies have yet to be approved.

LaRC anticipates new fleet management goals in FY 2022 and beyond due to EO 14057. Per the EO, all Federal fleet acquisitions must be 100% zero emission vehicles (ZEV) by 2035, including 100% light-duty ZEV acquisitions by 2027. Access to electric vehicle supply equipment (EVSE) will be critical for effective ZEV deployment. Collaboration across programs, including facilities and energy will be vital to planning for future EVSE sufficient for a 100% ZEV fleet. Additional specific strategies for LaRC to achieve the Center's future sustainable fleet management goals will be driven by the EO implementation guidance and HQ.

7.5 Opportunities for Program Improvement

Opportunities for improving fleet management at LaRC include:

- a. Continue planning for the installation of EVSE at LaRC, including conducting a comprehensive site assessment to plan for efficient deployment of necessary charging or refueling infrastructure.
- b. When replacing fleet vehicles, replace high mileage gasoline or diesel vehicles with ZEVs.
- c. Implement an awareness program to disseminate sustainable fleet and green building information to Center personnel to improve understanding and encourage adoption of the technologies.
- d. Collaboration with local and regional entities, including utilities, regarding strategies and lessons learned for future EVSE development and implementation.

8 Goal: Sustainable Acquisition

8.1 Goal Description

Increase the percentage of agency contract actions and increase in percentage of obligations (in dollars) containing statutory environmental requirements.

According to NASA's SRIP, the annual goals for sustainable acquisition are:

Goal for FY 2020: 17% of contract actions and 19% of obligations (in dollars). **Progress for FY 2020:** 20% of contract actions and 20% of obligations (in dollars). **Goal for FY 2021:** 21% of contract actions and 21% of obligations (in dollars).

8.2 Center Status

• 44% of LaRC's contract actions and 22% of obligations (in dollars) contained statutory environmental requirements in FY 2021.

Contracting Officers (COs) at each Center record sustainable acquisition activity in the Federal Procurement Data System (FPDS) based on specific sustainability data element choices in FPDS that are applicable to a procurement. The data reported in the FPDS allows HQ to collect required information for the Agency SRIP submission.

The number of contract actions reported by LaRC and amount of obligated dollars containing environmental procurement requirements are detailed below.

	FY 2019	FY2020	FY2021
Total # of Contract Actions Awarded	137	135	179
# Actions Including Environmental Clauses	63	64	78
Total Procurement Dollars Obligated	\$96,640,555	\$81,997,915	\$123,835,931
Amount Obligated Including Environmental Clauses	\$45,421,059	\$36,462,418	\$27,860,928

Table 8 – LaRC Sustainable Acquisition Contract Actions

LaRC met the Agency target for the number of contract actions and obligations (in dollars) containing statutory environmental requirements at the Center-level. In FY 2021, 44% of LaRC's contract actions and 22% of its obligated dollars contained statutory environmental requirements, which is a Center-level decrease for actions from FY 2020. Although there was an increase in overall contraction actions at LaRC, there was a decrease of sustainable clause applicability due to a reduction in specific sustainable acquisition-related contract actions. In support of the Agency's goal, LaRC's OP continues to work towards ensuring that the maximum number of its applicable contract actions require the supply/use of sustainable products and services.

NASA HQ also distributes a NETS green purchasing data call annually, and each Center is required to compile information on Center purchases of items designated under the EPA Comprehensive Procurement Guidelines (CPG) and United States Department of Agriculture's (USDA) BioPreferred Program. Based on the data received from the FY 2021 data call, LaRC purchasers and applicable contracts reported \$334,996 spent on items designated under the EPA's CPG. \$228,848 of that was spent on products that contained recovered/recycled content. Purchasers and applicable contracts reported \$277,700 spent on products in USDA-designated BioPreferred categories. \$20,204 of that was spent on products that contained biobased content.

In support of the Agency's goal, LaRC's OP continues to work towards ensuring that the maximum number of its applicable contract actions require the supply/use of sustainable products and services.

8.3 Highlights

• The EMO conducted sustainable acquisition training for LaRC's Contractor Steering Council. The training reviewed the environmental procurement programs, as well as the sustainable acquisition FAR clause requirements and associated reporting deliverables.

8.4 Implementation Methods and Planning Actions

LaRC's Procurement Policy Officer serves as the OP Representative on the EMC and is responsible for ensuring that applicable requirements for green purchasing are fulfilled in accordance with the FAR, NASA FAR supplement, NPR and LPR. LaRC OP and EMO staff assist COs with understanding the environmental procurement programs so they are able to place the appropriate FAR provisions and clauses in solicitations and contracts, screen procurement requirements to determine if environmental programs apply, and record activity accurately in FPDS. OP also forwards statements of work and solicitations to EMO for review to ensure applicable environmental requirements are appropriately included in the solicitation.

LaRC COs and Purchase Requisitioners utilize the NF 1707, *Special Approvals and Affirmations of Requisitions*, as a guide to determining applicable sustainable acquisition procurement requirements. 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.

LaRC's participation in the RSA CoP ensures appropriate coverage of sustainable acquisition requirements and pursuit of initiatives to increase the use of environmentally friendly products. Several EMO members attended the two-day RSA virtual CoP meeting in FY 2021 and anticipate participating in FY 2022.

LaRC promotes use of environmentally preferable products through outreach and training. In FY 2022, LaRC OP expects to attend an environmental course conference being held virtually through the Northeast Recycling Council. The conference will focus on various topics in sustainable materials management, including acquisition. LaRC OP will share and disseminate information from the conference with procurement personnel as applicable.

LaRC anticipates new sustainable acquisition goals in FY 2022 and beyond due to EO 14057. In addition to acquisition actions and initiatives associated with other goals set by the EO, EO 14057 directs agencies to purchase sustainable products and services identified or recommended by the EPA to the maximum extent practicable and after meeting statutory requirements. The EO also sets an ambitious goal to achieve net-zero emissions from Federal procurement by 2050, which includes launching a "Buy Clean" initiative for low-carbon materials and updating Federal procurement rules to include factoring in the social cost of greenhouse gases in procurement decisions. Additional strategies for LaRC to achieve the Center's sustainable acquisition goals will be driven by the EO implementation guidance, NASA HQ, and the FAR.

8.5 Opportunities for Program Improvement

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

- a. LaRC could work with HQ and RSA to ensure that FPDS data on new awards entered by NASA contracting personnel accurately reflect actual sustainability clauses in contract awards, conducting data reviews and additional training of NASA personnel inputting into FPDS.
- b. OP, with assistance from EMO, 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.
- 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 contract performance review.

d. Due to its close relationship with Joint Base Langley Eustis, LaRC should continue to partner with the Department of Defense on future biobased product testing projects.

9 Goal: Electronic Stewardship

9.1 Goal Description

Ensure sustainable electronics management:

- Newly purchased or leased equipment meets energy efficiency requirements.
- Equipment has power management enabled (excluding exempted equipment).
- Electronic equipment disposed using environmentally sound methods.

9.2 Center Status

IT end-user services are provided through the NASA End-user Services & Technologies (NEST) contract and administered through the Agency's End User Services Program Office (EUSO) program that spans all NASA centers. The EUSO manages most computers at LaRC and per LaRC's Office of the Chief Information Officer (OCIO), the EUSO contract complies with sustainable requirements regarding electronic assets. The EUSO contract includes the appropriate clause language requiring Electronic Product Environmental Assessment Tool (EPEAT) compliance and energy savings, including energy saving equipment and how to handle the final disposition of equipment.

Center Multifunction Devices (MFDs) are configured with both power management and duplex printing by default and NEST electronic services are configured with power management by default; there is currently no estimate of non-NEST equipment with power management enabled (excluding exempt equipment).

LaRC complies with the General Services Administration (GSA) procedures for the transfer, donation, sale and recycling of electronic equipment at end-of-life.

9.3 Highlights

- LaRC implemented Power Utilization Efficiency (PUE) upgrades in the Computational Research Facility (CRF) Data Center room 142 and the Tape Library room 141. This allows for continued data center optimization and subsequent energy use conservation.
- The cumulative annual CRF PUE for the CRF Data Center (B2103) in FY 2021 was 1.47, which exceeds the Agency PUE target of 1.5.
- LaRC's Atmospheric Science Data Center PUE improved from 2.01 to 1.90 in FY 2021.
- LaRC created customized dashboards within its Trane Ensemble application so customers can monitor power utilization for their IT racks. Customers can view power amperage utilized per power phase, branch output power, power factor, and any branch overcurrent or undercurrent alarms. With this information, the customer will be able to determine whether their IT equipment is balanced across the three power phases and make adjustments if needed. In addition, underutilized IT racks can be identified.

9.4 Implementation Methods and Planning Actions

NASA continues to utilize Desktop Computing Standards that provide a common framework for consistent IT practices across all NASA Programs and Centers. NASA-STD-2804, Minimum Interoperability Software Suite states that printers, laptops, and desktop systems must be configured to use energy-saving settings to comply with sustainability goals. NASA-STD-2805, Minimum Hardware Configurations states that all newly procured systems shall be EPEAT Gold where possible or be Energy Star certified devices. NASA incorporates these standards in all IT procurement contracts. The normal refresh cycle for the Agency Consolidated End-User Services enterprise contract for procured office automation equipment is maintained, ensuring 100% compliance with EPEAT standards. NASA ensures its Enterprise IT Support and Services contracts contain clauses on environmentally

sound practices for disposition of all Agency excess or surplus equipment.

As part of the electronics stewardship program at LaRC, government-furnished electronic products that reach endof-life are reused, donated, sold, or recycled using environmentally sound management practices. 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. 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.

Several energy efficient options are utilized on electronic products at LaRC, such as the MFDs having standardized configurations for duplex and black and white printing, reduced toner density, and enabled sleep mode. OCIO follows the National Institute of Standards for power management for each operating system used at LaRC, except for putting systems into hibernation mode when not in use. This exception allows software pushes, patches, and backups to be implemented as needed.

LaRC's OCIO is working to implement the NIyte Energy Optimizer (NEO), a data center infrastructure management tool. Key benefits of the tool include: (1) the ability to quickly identify unused and under-powered infrastructure to reduce costs; (2) maximize uptime, capacity, and assets via simulated failures so customers can plan ahead; and (3) proactively anticipate and analyze at-risk scenarios to steer clear of failures.

Additionally, LaRC will be working with the Agency Data Center Consolidation team in FY 2022 to create a new Computational Fluid Dynamics (CFD) model of the CRF data center floor to identify other areas that can be modified to ensure energy optimization.

As part of the net-zero emissions buildings goal, EO 14057 directs agencies to improve energy efficiency of onsite data centers. Specific improvement goals, along with implementation guidance and methodologies, have yet to be prescribed. Additional energy efficiency strategies for LaRC to achieve the Center's electronic stewardship and data center goals will be driven by the EO and associated implementation guidance.

9.5 Opportunities for Program Improvement

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

- a. Implement additional data center improvements potentially identified by new CFD.
- b. 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. 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. Contracts at LaRC already in place and in progress could be audited by OP and OCIO to ensure EPEAT and energy efficiency purchasing contract requirements are being met and sound disposition methods for contract electronic products are employed.

10 Goal: Greenhouse Gas Emissions

10.1 Goal Description

Reduce agency Scope 1 and 2 emissions compared to 2008.

This goal is tracked at the Agency level. Scope 1 (onsite, sources owned by NASA) and Scope 2 (offsite, from purchased electricity, heat or steam) emissions are reported in metric tons CO₂ equivalent (MtCO₂e).

The NASA SRIP shows NASA reduced Scope 1 and 2 GHG emissions 44.4% from FY 2008 through FY 2020. The FY 2008 Scope 1 and 2 emissions base line was 1,225,300 MtCO₂e. For Scope 2 purchased electricity, NASA's largest emissions source, emissions decreased more than 50 percent since FY 2008. The primary reason is the agency's on-site electricity consumption dropped 30 percent. Since FY 2008, NASA Centers have actively reduced Scope 1 and 2 emissions by substituting more energy-efficient equipment and renewable energy generation, replacing or modernizing inefficient buildings, and carefully managing transportation fuel. COVID-19 impacts also reduced Scope 1 and 2 emissions in FY 2020 and 2021.



10.2 Center Status

LaRC's Scope 1 GHG emissions come from stationary research and utility equipment which combust natural gas and fuel oil. This includes B1265 high temperature wind tunnel combustor, B1236 NTF wind tunnel exhaust stack heaters, B1237A Lindberg wax furnace, steam boilers at B1215 and B647, and individual building space heaters and hot water boilers. The spike in 2015 was caused by the B1215 steam plant's emissions from natural gas combustion, which was high because the steam supply line from the Waste-to-Energy Facility was shut down for repair. 2021 emissions are up slightly from 2020. Langley's steam plant and heating equipment had to continue to operate regardless of restricted Center access due to COVID-19, and some research work continued at B1265 and B1236. The Mandatory GHG Reporting Rule (40 CFR Part 98) requires facilities whose stationary combustion sources generate more than 25,000 MtCO₂e per calendar year to report the emissions to EPA. LaRC's emissions are well below this reporting trigger.

10.3 Highlights

See efforts under Goals 1, 5, and 7.

10.4 Implementation Methods and Planning Actions

LaRC uses as much of the steam produced by the Waste-to-Energy Facility as possible, to minimize onsite fossil fuel combustion for steam production. Other efforts include the energy reduction, renewable energy, and fleet management work described in earlier chapters.

EMO staff report energy data and ozone depleting and global warming substances use data in NETS. NASA HQ uses this data for GHG reporting and tracking. EMO participates in NASA Regulatory Risk Analysis and Communication Principal Center technical teleconferences to stay current with GHG requirements.

LaRC anticipates new GHG management and reductions goals for FY 2022 and beyond due to EO 14057. The EO directs the Federal Government to reduce its GHG emissions by 65% by 2030 from 2008 levels, with the intent to achieve an ambitious goal of net-zero emissions from Federal operations by 2050. The fleet management, clean energy, and buildings emissions goals set by the EO are the primary drivers by which GHG emissions reductions are expected to be achieved. Per the EO, each agency will set and meet reduction targets for 2030. The guidance and methodologies for setting these goals have yet to be prescribed. Additional specific strategies for NASA (and LaRC) to achieve GHG reduction goals will be driven by the EO implementation guidance.

10.5 Opportunities for Program Improvements

NASA is committed to reducing GHG emissions through life-cycle cost-effective strategies, mainly involving energy conservation. Efforts include upgrading to more efficient building utility equipment (such as boilers, furnaces or emergency generators), replacing or renewing older buildings to improve their energy efficiency, and reducing building square footage to the maximum extent practical.

11 Climate Change Resilience

11.1 Description

EO 13834 did not set climate change resiliency goals for agencies. However, EO 13990 (which revoked EO 13834), EO 14008, *Tackling the Climate Crisis at Home and Abroad*, and EO 14057 have recently refocused Federal efforts on climate change and identified climate considerations as an essential element of national security.

11.2 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 to manage and minimize the potential effects of these risks on operations, mission, and infrastructure: the Center's Revitalization (Master) Plan and green infrastructure initiatives, 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.

11.3 Highlights

The following initiatives highlight LaRC's progress in toward preparing for and mitigating the effects of climate change at the Center:

- LaRC continues to construct new, climate resilient, energy efficient buildings within the Center's main core campus area. Siting the buildings within the highest elevation areas reduces the risk from flooding and sea level rise. Additionally, the energy efficient, green buildings will reduce LaRC's carbon footprint due to reduced energy consumption and emissions.
- LaRC continues to focus on implementing innovative low impact design stormwater management practices. These practices include reducing impervious surfaces, using vegetation to treat and absorb stormwater, and installing porous pavements, bio-retention systems, pre-manufactured BMPs, and green roofs. These types of projects reduce flooding and site runoff volumes.
- LaRC continues to demolish outdated, inefficient and underutilized buildings and infrastructure and return impervious surfaces to pervious open green space.

11.4 Implementation Methods and Planning Actions

Center Master Planning Process. LaRC's Master Plan incorporates adaptation strategies to address potential climate change impacts at the Center. Examples are shown in Table 9 below:

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 Re-establish/expand riparian buffer 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.

Table 9 – Master Planning and Climate Adaptation Strategies

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 design requirements to improve stormwater runoff, removing unneeded parking areas to increase pervious areas).

LaRC GIS Team Support. The GIS Team's Flood Impact Analysis Tool provides detailed facility and utility data to support storm impact studies and potential storm hardening projects at LaRC.

Partnerships. LaRC works closely with Joint Base Langley Eustis, the City of Hampton, the City of Poquoson, and other stakeholders in various planning and partnering efforts, including climate resiliency, stormwater management, and master planning.

Beginning in FY 2022, key LaRC personnel will participate in HQ's Climate Adaptation Science Investigations (CASI) which will develop tools and information that will assist Centers in better understanding climate impacts and key hazards. The effort will provide projections using latest models and data for both near term and long-term time periods for improved climate risk management strategies.

11.5 Opportunities for Program Improvement

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

- a. Continue utilizing and improving data gathering and information management tools to facilitate long-term planning for climate change.
- b. Continue storm hardening of infrastructure.
- c. Continue collaborating with local community partners and stakeholders on climate change adaptation and resilience strategies.
- d. Establish a Climate Change Adaptation Working Group to evaluate climate change risks at the Center, prioritize mitigation and adaptation initiatives, and ensure climate change resilience is integrated into LaRC's programs and policies.

12 APPENDIX A - ACRONYMS AND ABBREVIATIONS

BTU British thermal unit C&D Construction and Demolition **CFE** Carbon-Free Electricity **CO** Contracting Officer **COD** Center Operations Directorate **CPG** Comprehensive Procurement Guidelines **CRF** Computational Research Facility **CSO** Center Sustainability Officer **EEP** Energy Efficiency Panel **EET** Energy Efficiency Team **EMO** Environmental Management Office **EMS** Environmental Management System **EMSP** Environmental Management and Sustainability Plan **EO** Executive Order **EPA** Environmental Protection Agency **EPEAT** Electronic Product Environmental Assessment Tool **ESPC** Energy Savings Performance Contract **EUSO** End User Services Program Office **EVSE** Electric Vehicle Supply Equipment FAR Federal Acquisition Regulation FC Facility Coordinator FEC Facility Environmental Coordinator FEMP Federal Energy Management Program FPDS Federal Procurement Data System FSH Facility Safety Head FY Fiscal Year GGE gasoline gallon equivalents **GHG** areenhouse das **GIS** Geographic Information Systems **GSA** General Services Administration **GSF** Gross Square Foot **HQ** Headquarters HVAC Heating, Ventilating and Air Conditioning IT Information Technology **kW** kilowatt kWh kilowatt hour LaRC Langley Research Center **LEED** Leadership in Energy and Environmental Design LEED-NC LEED certification program for New Construction LMO Logistics Management Office LPR Langley Procedural Requirement **LSEV** Low Speed Electric Vehicle **MFD** Multi-Function Device MtCO2e Metric Tons of Carbon Dioxide Equivalent **MW** Megawatt **MWh** Megawatt hours **NASA** National Aeronautics and Space Administration **NEST NASA End-user Services & Technologies NETS** NASA Environmental Tracking System NPR NASA Procedural Requirement OCIO Office of the Chief Information Officer **OMB** Office of Management and Budget **OP** Office of Procurement **PUE** Power Usage Effectiveness

PV Photovoltaic REC Renewable Energy Credit RSA Recycling and Sustainable Acquisition (Principal Center) SATERN System for Administration, Training, and Educational Resources sf square feet or square foot SRIP Sustainability Report and Implementation Plan UESC Utility Energy Service Contract USDA US Department of Agriculture ZEV Zero Emission Vehicle This page left blank intentionally