

National Aeronautics and Space Administration

Sustainability Report and Implementation Plan

2020



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National Aeronautics and Space Administration
2020 Sustainability Report and Implementation Plan

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Executive Summary

NASA's Mission and Sustainability

We reach for new heights and reveal the unknown for the benefit of humankind. We do this through our missions of scientific discovery of the Earth and its solar system, of other worlds, and of the cosmos as a whole; missions of human spaceflight and operations in and beyond low-Earth orbit; and missions of development that advance new technologies in aeronautics and space systems. As noted in NASA's 2018 Strategic Plan, NASA's "mission support strategy is to steward resources by reducing costs, revitalizing capabilities, integrating capabilities across the Agency, and optimizing operations."

NASA operates ten primary Centers and seven specialized Component Facilities in locations around the country, comprising approximately 47 million square feet in 5,000 buildings. The Agency employs 16,250 full-time civil servants, supported by a significant contractor workforce providing technical and business operations services.

NASA strives to accomplish its mission with the utmost care, recognizing that the Agency safeguards taxpayer dollars and one-of-a-kind, often historic, facilities.

NASA's sustainability policy is to execute the mission without compromising the planet's resources so that future generations can meet their needs. In the risk management culture of NASA, that means we use proactive measures to reduce NASA's environmental, institutional, programmatic, and operational risks. In doing so, we continuously improve the resilience of NASA's space and ground asset operations and performance.

Current Sustainability Successes

As an applied example of the sustainability policy, the Agency's energy management program reduces risk to NASA's mission by minimizing potential impacts of energy insecurity while also increasing the cost effectiveness of finite resources. The cost avoidance in our fiscal year (FY) 2019 energy bill was \$29.3 million (calculated based on comparing FY 2003 energy consumption at FY 2019 unit costs versus actual FY 2019 expenditures). NASA continues to reduce the footprint of its portfolio of built assets through strategic demolition and consolidation efforts. The design of new facilities or major upgrades to existing buildings minimizes long-term infrastructure energy, water, and maintenance costs. In FY 2019, NASA managed several new construction projects and completed one high performance facility with more than 200,000 gross square feet (GSF) added to the sustainable facility inventory. In FY 2019, NASA demolished 25 facilities with a net reduction of more than 68,000 square feet of building space.

Future Sustainability Priorities

NASA reports its overall accomplishments to Congress, the Office of Management and Budget (OMB), and the public through the [Agency's Volume of Integrated Performance](#), a detailed look at the Agency's performance against four high-level Strategic Goals. This report includes NASA's Annual Performance Plan, which consists of multiyear performance goals and annual performance targets consistent with the Agency's Strategic Plan and annual budget request, and the Annual Performance Report, detailing progress toward achieving the performance goals. Specific performance goals relating to the annual Sustainability Plan are tied to the NASA 2018 Strategic Plan's Objective 4.6, which is to "Sustain infrastructure capabilities and operations." Performance Goal 4.6.2 is to "Improve NASA's ability to operate facilities sustainably and reduce overall resource demands." Beginning in FY 2020, NASA is assessing performance for Goal 4.6.2 using the Agency's OMB Scorecard for Efficient Federal Operations/Management which ensures a broader Agency focus on all aspects of federal sustainability.

Beginning in FY 2020, NASA is reporting additional qualitative and quantitative evidence to demonstrate performance on sustainability goals, focusing primarily on energy reduction initiatives in the Agency's most energy-intensive facilities (most of which are excluded from the OMB scorecard energy metric due to their mission-driven energy consumption) and on sustainable acquisition of energy-efficient equipment.

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Sustainability is tracked by NASA internally. A goal of the Office of Strategic Infrastructure is to implement risk mitigation and sustainability practices across the Agency's infrastructure to prevent adverse mission impacts, protect mission resources, and enable the NASA mission to the fullest extent possible.

NASA's strategic priorities and objectives for FY 2021–2022 are to advance efficiency and sustainability in Agency operations, meet or exceed goals and requirements, and achieve cost savings by executing several actions:

- Piloting U.S. Department of Energy's (DOE) 50001 Ready Program across the Agency to ensure energy and water management best practices and deep, persistent energy and water consumption reduction and cost savings.
- Continuing implementation of the Strategic Energy Investment Plan (SEIP), which prioritizes energy efficiency projects that decrease facility costs and improve reliability (FY 2019 was the first year of Agency investment informed by the SEIP).
- Expanding the scope of energy efficiency-focused investments to include mission-intensive facilities that are Significant Energy Users (SEU) excluded from federal energy reduction mandates and that were not assessed in the SEIP.
- Continuing the Existing Building Commissioning Program, which was implemented in FY 2018 and focuses on bringing existing buildings back into top performance.
- Continuing to aggressively reduce the Agency's footprint by demolishing old, inefficient buildings and replacing them, where necessary, with sustainable, high efficiency buildings.
- Continuing to improve sustainable acquisition compliance rates and best practices.
- Prioritizing and resourcing sustainability initiatives according to impact to NASA and developing an Agency-wide outreach campaign at each Center and Component Facility to support implementation of these initiatives.

More information on NASA's future sustainability plans can be found in NASA's [2018 Strategic Plan](#) (see pages 43-44) and the [FY 2021 Full Budget Request](#) (see Safety, Security, and Mission Services section and Construction and Environmental Compliance and Restoration section).

Note on SARS-CoV-2 (COVID-19) Impacts

Some of the goal sections in this Report mention the potential impacts of the COVID-19 pandemic on FY 2020 activities. For FY 2020, many sustainability indicators will be significantly different from other years. Comparing FY 2020 numbers to previous years or to FY 2021 may be misleading. The closure of most NASA Centers and Facilities for more than three months—coupled with reduced on-site work as the workplaces reopen—will have an impact on water, energy, waste, fleet, and greenhouse gas measures. As construction was halted in March, the schedule for construction of new sustainable buildings and re-commissioning of existing buildings also will be affected. Nevertheless, NASA is actively pursuing innovative ways to improve sustainability outcomes. The pandemic has provided new insights into NASA's daily operations. In particular, implementing increased work from home options may contribute to federal energy and water savings.

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Implementation Summary: Facility Management

1. FACILITY ENERGY EFFICIENCY

FY 2019 Energy Intensity Progress (Btu/GSF):

41.3% reduction from FY03

3.2% reduction from FY18

FY 2020-FY 2021 Plan:

1.0% reduction in FY20 from FY19

0.5% reduction in FY21 from FY20

NASA seeks to accomplish its current and future mission using the minimum amount of energy and water required. The NASA Energy and Water Management Program achieves this vision by ensuring resource affordability, reliability, and sustainability through utility supply cost management, life-cycle cost-effective project implementation, and facility operation and maintenance optimization.

Implementation Status

In FY 2019, NASA's energy intensity for goal-subject facilities continued its long downward trend. NASA's core strategies include energy efficiency and renewable energy project implementation; operations and maintenance best practices; sustainable building design, construction, and renovation; and employee training, outreach, and awareness.

Examples in FY 2018 and FY 2019 include actions at several Centers:

- Goddard Space Flight Center (GSFC), Langley Research Center (LaRC), Marshall Space Flight Center-Michoud Assembly Facility (MAF), and Stennis Space Center (SSC) completed light-emitting diode (LED) lighting upgrades.
- Armstrong Flight Research Center (AFRC) and Johnson Space Center (JSC) upgraded heating, ventilation, and air conditioning (HVAC) equipment.
- GSFC completed control upgrades to its central utility plant.
- Glenn Research Center (GRC) completed an expansion of its Energy Management Control System.
- Jet Propulsion Lab (JPL) implemented the first phase of its no-cost Smart Scheduling project to reduce unnecessary HVAC operations.

These projects are projected to save 51 billion British thermal units (Btu) annually, with an avoided cost of \$990 thousand.

Multiple Centers also implemented performance contracts, installed renewable energy projects, and constructed high performance sustainable buildings as detailed in later sections. Ongoing infrastructure repair and replacement projects, such as JSC's project to replace insulation on miles of steam and chilled water pipes, also improve energy efficiency.

NASA continues its cyclical Existing Building Commissioning Program using Agency Enhanced Use Lease (EUL) net revenue. Initiated in FY 2018, NASA has used this program to invest \$10.7 million in repairs and upgrades across nine Centers, with FY 2020 investments currently being evaluated. NASA also continues its Construction and Environmental Compliance and Restoration appropriation for recurring direct investment in energy and water efficiency and renewable energy improvements. In addition, NASA continues to integrate energy and water planning with the Agency master planning process to better align energy and water initiatives with other facility affordability and reliability efforts.

Priority Strategies & Planned Actions

In FY 2019, NASA began three major programmatic initiatives that will have long-term impacts on its energy consumption and cost:

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- NASA is piloting the DOE 50001 Ready program (based on the International Organization for Standardization (ISO) 50001 standard, Energy Management System) across the Agency to ensure all NASA locations are continually improving energy management with demonstrable, quantifiable results and deep, persistent energy and water savings. NASA partnered with DOE's Federal Energy Management Program (FEMP) to receive free implementation support and training through recurring webinars and virtual office hours. Starting in FY 2020, all NASA locations are benchmarking their programs against the DOE 50001 Ready requirements, identifying critical program gaps, and developing FY 2021 action plans to address the gaps. For example, the NASA Headquarters (HQ) energy team identified facility data integration and analysis capabilities as a major gap for Agency-wide energy portfolio management and is developing plans to improve NASA's energy and water data management.
- Approximately 40% of NASA's energy is used in facilities excluded from the energy intensity reduction goal. Many of these exclusions are due to unique mission applications (e.g., wind tunnels and high pressure compressed air plants). As a result of this excluded status, most of these facilities were historically excluded from energy efficiency investments. NASA recognized this gap and in FY 2019 began identifying and quantifying types and classes of facilities that are SEUs regardless of goal status. This work continues in FY 2020 and beyond to identify and prioritize energy and water efficiency investments and initiatives in these SEUs. The Agency identified this initiative as a priority for overall infrastructure sustainability.
- In early 2020, NASA initiated an Agency-wide campaign to increase awareness of its sustainability priorities and objectives described throughout this report. This includes specific elements for energy efficiency and conservation. This will be an annual effort that builds on itself from year-to-year, targeting specific audiences and behaviors and reducing some of the burden on NASA Centers that are required to implement their own campaigns.

NASA will continue to evaluate covered facilities for potential energy and water efficiency measures and incorporate these into future energy and water investments. To optimize resources available for comprehensive facility evaluations, NASA issued internal guidance to its Centers for incorporating remote audits for existing covered facilities that have been evaluated multiple times and have not had all conservation measures implemented.

NASA expects these initiatives to support continual operational improvement; however, many of the remaining efficiency measures have higher costs, longer paybacks, and/or are located in highly specialized facilities. Therefore, while NASA's long-term trend in energy reduction is still moving in the right direction, progress likely will be less dramatic than in past years. Operational issues or changes in operational tempo have greater influence on year-over-year metrics.

2. EFFICIENCY MEASURES, INVESTMENT, AND PERFORMANCE CONTRACTING

FY 2019 Performance Contracting – Investment value and number of new projects awarded:

\$18.7 million / 4 Projects in FY19

FY 2020-FY 2021 Plan:

\$21.2 million / 1 Project in FY20

\$19.1 million / 1 Project in FY21

NASA uses Energy Savings Performance Contracts (ESPC) and Utility Energy Service Contracts (UESC) in concert with other mechanisms to improve systems efficiencies, reduce utilities expenditures, and improve resilience in support of NASA's mission.

Implementation Status

In FY 2019, NASA awarded one ESPC and three UESCs with a combined \$18.7 million investment value, surpassing the plan to award \$14.5 million in FY 2019 by more than \$4.2 million. These four projects varied geographically and in scope, impacting multiple operational and sustainability goals. SSC awarded an energy and water efficiency UESC in October 2018, Goddard Space Flight Center-Wallops Flight Facility (GSFC-WFF) awarded a solar photovoltaic (PV) ESPC modification in February 2019, and in September 2019, AFRC awarded a lighting UESC and GSFC awarded an existing

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building commissioning UESC. These contract activities are estimated to annually avoid 56.5 billion Btus of energy and \$1.1 million in energy and related expenditures.

Priority Strategies & Planned Actions

NASA will implement and monitor energy performance contracts awarded in FY 2019. Centers continue to develop potential ESPC and UESC projects. Several are at different project development phases ranging from initiating preliminary assessments through reviewing investment grade audits and feasibility studies. NASA based its FY 2020 planned investment on the most mature potential project under development—working to finalize a broad UESC at Kennedy Space Center (KSC). Pending completion of the feasibility study and contract award, NASA anticipates this UESC will annually avoid approximately 42.3 billion Btus of energy, 5.6 million gallons of water, and \$2.4 million in energy and related expenditures. Due to project complexity and COVID-19 impacts on cross-organizational interaction, contract award will likely occur in FY 2021 instead of FY 2020. NASA based its FY 2021 goal on other potential ESPC or UESC activity beyond the KSC UESC project.

3. RENEWABLE ENERGY

FY 2019 Renewable Electricity Use:

13.1% of total electricity in FY19

FY 2020-FY 2021 Plan:

7.5% of total electricity in FY20

7.5% of total electricity in FY21

NASA's overarching strategy for renewable energy is to install on-site renewable generation wherever life-cycle cost-effective or where needed for critical infrastructure resilience and to buy additional Renewable Energy Certificates (REC) if necessary to meet federal goals.

Implementation Status

While NASA achieved a 13.1% renewable electricity use rate in FY 2019, this high use rate was the result of REC purchases under existing multi-year contracts that were developed to meet prior federal goals.

NASA Centers employ a diverse mix of renewable sources and technologies, including on-site electricity and thermal energy generation or conversion, direct purchases, a hosted solar PV project, and REC purchases. On-site generation ranges from small solar parking lot lighting to larger geothermal heat pump systems and solar PV systems, with additional projects in progress. Fifteen NASA Centers and Component Facilities have installed electric and/or thermal renewable energy on-site through 58 individual projects.

Many Centers completed renewable energy projects in FY 2018 and FY 2019:

- KSC installed approximately two megawatts (MW) of additional solar PV as an expansion to its existing 900 kilowatt (kW) system. Commissioning was completed at the end of FY 2018, so FY 2019 was the first full FY of generation, with 2,417 megawatt hours (MWh) of electricity produced in the FY.
- JSC-White Sands Test Facility (JSC-WSTF) commissioned a 1.6 MW solar PV plant in FY 2019, with 2,398 MWh of electricity produced in the FY. This solar installation will offset high energy demands from the groundwater remediation system and will provide resiliency during power outages.
- KSC and Marshall Space Flight Center (MSFC) both completed rooftop solar installations in FY 2019. At KSC, a 125 kW system was completed at the end of the FY. At MSFC, a 120 kW system was completed part way through the FY, with 102 MWh of electricity produced in the FY.
- JPL is adding approximately 900 kW of solar PV on a parking structure. This system joins other rooftop systems at JPL, as available land area is very limited. Project implementation began in FY 2018 and continued through FY 2019. Commissioning was expected in May 2020; however, COVID-19 restrictions will delay the project.
- JSC-WSTF and GSFC-White Sands Complex (GSFC-WSC) initiated a solar PV and energy storage project in FY 2018. The National Renewable Energy Laboratory is providing assistance, including site-specific analysis of

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on-site generation and storage needs. JSC-WSTF is pursuing microgrid-ready capabilities, and both sites will benefit from significant improvements to their electrical systems at project conclusion. Preparation to award a design-build contract continued through FY 2019 and FY 2020.

- GSFC-WFF awarded a contract modification for incorporating a total of 4.3 MW of solar PV into the existing WFF ESPC project. The project was commissioned in the middle of FY 2020.

A breakdown demonstrating how NASA achieved this metric is provided in the table below.

Renewable Type	Quantity Reported	NASA Total	Metric
On-site Generation	7,561.5 MWh	4.8%	0.6%
On-site Generation Bonus	7,561.5 MWh	4.8%	0.6%
Purchased from Off-site Fed.	2,374.8 MWh	1.5%	0.2%
Purchased from Off-site Fed. Bonus	2,374.8 MWh	1.5%	0.2%
Hosted Project RECs	16,852.0 MWh	10.7%	1.4%
Purchased RECs	120,705.0 MWh	76.7%	10.0%
Metric Total	157,429.6 MWh	100.0%	13.0%
On-site Non-electric	549,502.0 MBtu	N/A	N/A
Purchased from Off-site Fed. Non-electric	148,229.0 MBtu	N/A	N/A

Priority Strategies & Planned Actions

NASA will continue to install on-site renewable generation wherever life-cycle cost-effective or where needed for critical infrastructure resilience. The Agency SEIP summarizes potential renewable energy projects (solar, wind, and storage) at each Center and provides estimates for economic viability. Based on this analysis, NASA is now strategically funding renewable energy projects that provide the most economic and resiliency benefit to the Agency; please see the JSC-WSTF and GSFC-WSC project summary in the Implementation Status section above. Other planned actions include continued efforts to work with local utilities and/or adjoining military installations on potential projects.

NASA recently signed EUL agreements at MAF and KSC to host utility-scale solar PV on non-excess underutilized real property in exchange for cash payments. MAF will host 20 MW on approximately 100 acres. Construction began in February 2020 and is approximately 60% complete. KSC will host 74.5 MW on approximately 491 acres. Land clearing began in April 2020 with estimated project completion in FY 2021. In both projects, production will feed directly into the utility provider's grid.

Beginning in FY 2020, NASA is centralizing REC purchases at the Agency level to reduce costs and gain administrative efficiencies. The Agency procurement effort forecasted the amount of RECs necessary to complement other renewable energy activity and achieve the statutory 7.5% renewable energy requirement.

4. WATER EFFICIENCY

FY 2019 Water Intensity Progress (Gal/GSF):

34.3% reduction from FY07

7.1% increase from FY18

FY 2020-FY 2021 Plan:

0.5% reduction in FY20 from FY19

0.5% reduction in FY21 from FY20

The overarching strategy and approach to reducing potable water consumption focuses on upgrading infrastructure, installing metering, and reducing water waste through no-cost or low-cost measures. Stormwater management is incorporated into NASA construction projects through Leadership in Energy and Environmental Design (LEED) and Guiding Principles for Federal Sustainable Buildings where applicable.

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Implementation Status

In FY 2019, although NASA's water intensity was still well below the FY 2007 baseline, water use intensity continued an upward trend from FY 2016. The increase in FY 2019 from the prior year results from mission requirements, construction projects, flushing programs, fire suppression system maintenance, and leaks. Lack of extensive metering and ongoing utility billing issues contributed to reporting complications throughout the FY.

For example, increases in wind tunnel activity have increased water consumption due to cooling tower evaporation losses and use of unrecoverable steam in vacuum-driven tunnel tests. In the future, missions such as Space Launch System program activity may also negatively affect progress.

Leaks from older, degraded systems continued to impact NASA's water consumption in FY 2019, and water system operations also present challenges, since drinking water quality standards often require flushing of distribution systems. This flushing requires large quantities of water to be pumped through the system and then discharged without being used, ensuring the water distribution lines are clean and that water quality has not degraded. Furthermore, most water projects—whether regular storage tank maintenance or complete line replacement—require flushing, hindering annual progress for water intensity reduction goals.

NASA continues to address these issues by upgrading major water infrastructure and replacing aging distribution systems, optimizing building HVAC systems, re-configuring fire protection systems, retrofitting restroom fixtures, reducing use of landscaping irrigation systems, and installing meters.

Actions from FY 2018 and FY 2019 include the following:

- AFRC, JSC, LaRC, MSFC, SSC, WFF, and WSTF reported ongoing building- or zone-level water metering projects.
- GSFC, JSC, and WSTF planned or conducted leak detection surveys.
- MAF completed three water leak identification and repair projects and plans a pipe replacement project for one building.
- JPL implemented a landscape plan which reduced water consumption by replacing turf areas with drought tolerant, native vegetation and rockscape.

Priority Strategies & Planned Actions

NASA Centers continue to conduct leak detection, install metering as appropriate, use water-efficient landscaping, and identify other water conservation measures.

NASA's implementation of the DOE 50001 Ready Program and the energy and water outreach awareness campaign described in the Facility Energy Efficiency section will result in improved water management across the Agency.

In FY 2020 and FY 2021, NASA HQ will analyze water metering gaps across the Agency and prioritize metering investments from an Agency-wide portfolio perspective to target the largest water users.

5. HIGH PERFORMANCE SUSTAINABLE BUILDINGS

FY 2019 Sustainable Buildings Progress:

43 sustainable Federal buildings
19.6% of buildings / 23.8% of gross square footage (GSF)

FY 2020-FY 2021 Plan:

25.0% of gross square footage (GSF) in FY20
26.0% of gross square footage (GSF) in FY21

NASA requires that new facilities meet the Guiding Principles for Sustainable Federal Buildings and earn at least a LEED Silver certification by the U.S. Green Building Council (USGBC), which manages an independent third party high performance sustainable building verification system. To reduce utility usage for existing buildings, NASA uses other funding opportunities including ESPCs and EUL net revenue to implement commissioning strategies.

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Implementation Status

In FY 2018 and FY 2019, NASA continued to improve the operational performance of existing buildings and construct new high performance sustainable facilities. Four new facilities were constructed totaling more than 185,000 GSF and meeting the Guiding Principles and LEED Silver criteria.

The WFF Island Fire Station, an emergency response and safety facility, was designed and constructed to withstand hurricane-force winds and storm surge. The LaRC Katherine Johnson Computational Research Facility design consolidates multiple data centers into one energy-efficient facility with independent backup power and cooling systems. The JSC Human and Health Performance Laboratory was aligned to optimize solar orientation to eliminate unwanted heat gain and solar glare. The WFF Mission Operations Control Center's high efficiency HVAC with air-cooled variable refrigerant flow, heat pump hot water with enthalpy wheel energy recovery, and geothermal systems contributed to 32% designed energy savings.

In 2019, operations at the JPL Central Engineering Building earned a LEED Operations and Maintenance Gold Certification for the building, meeting federal Guiding Principles. The facility, originally constructed in 1986, includes more than 200,000 GSF. JPL employed a multi-phase approach to improve the operations and performance of the facility using an integrated, enhanced commissioning program and a rooftop solar PV system.

Priority Strategies & Planned Actions

NASA's priority strategy is to construct sustainable buildings and demolish buildings that no longer meet mission needs and are therefore considered obsolete. Reflecting this, NASA continues to design and construct new high-performance sustainable facilities. Recently completed construction projects that are in the process of LEED third party sustainable building certification or will apply for certification in 2020 include the KSC Central Campus administration building (190,000 GSF) and the Ames Research Center (ARC) BioSciences Collaborative Facility, with 40,000 GSF of mixed-use traditional science lab and computer lab space with minimal office area. The MSFC Building 4221 administration facility (150,000 GSF) received LEED certification in June 2020. All facilities have been designed to meet LEED Silver certification. The Facilities Engineering Branch is also revising the NASA policy document for new construction and major renovation requirements to include the design requirements for assessing and considering climate risk changes, as addressed in the Guiding Principles for Sustainable Federal Buildings.

In addition to construction of new facilities, NASA is engaged in a program to "Reduce the Footprint" by 25–30%. For the recent five-year period through 2020, NASA will have demolished more than 1.5 million square feet of aging and inefficient properties. In 2021, NASA will complete construction and register three additional high performance sustainable buildings meeting the Guiding Principles and designed to meet LEED Silver certification. These three facilities, totaling over 280,000 GSF, include the LaRC Measurement System Laboratory (175,000 GSF); the GSFC Instrument Development Facility (54,000 GSF); and the GRC Research Support Building (52,000 GSF).

6. WASTE MANAGEMENT AND DIVERSION

FY 2019 Non-hazardous Waste Management and Diversion:

16,536 metric tons of non-hazardous solid waste generated*
56% diverted and 44% sent to treatment and disposal facilities

FY 2020-FY 2021 Plan:

1.0% reduction in non-hazardous solid waste generated in FY20 from FY19
50% diverted and <50% sent to treatment and disposal facilities in FY20

1.0% reduction in non-hazardous solid waste generated in FY21 from FY20
50% diverted and <50% sent to treatment and disposal facilities in FY21

**not including construction and demolition waste*

The current overarching strategy and approach to reducing waste is advancing waste prevention practices that lead to saving natural resources, conserving energy, reducing pollution, reducing waste toxicity, and saving money. Actions to

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reduce hazardous and non-hazardous waste generation and increase waste diversion follow the U. S. Environmental Protection Agency's (EPA) Waste Management [Hierarchy Pyramid](#).

Implementation Status

NASA continued to exceed its internal solid waste reduction goals in FY 2019 using several methods to support and improve hazardous and non-hazardous waste reduction efforts at NASA Centers: a) the Recycling and Sustainable Acquisition (RSA) Principal Center provided technical resources that supported waste reduction, recycling, and sustainable acquisition efforts; b) web-based collaboration tools promoted knowledge sharing and synergy; c) Environmental Management Systems (EMS) were used to track and evaluate hazardous chemical reduction and reuse activities and hazardous waste generation; and d) environmental awards programs promoted employee awareness. In FY 2019, of the 9,250 metric tons of waste diverted, 73% was recycled, 19% reused, and the remaining 8% was either donated, composted, or sent to energy recovery. NASA continued to exceed Agency construction and demolition (C&D) goals in FY 2019 by sending only 11% of C&D waste to the landfill.

- RSA supported community-of-practice members with a variety of communications paths for collaborative problem solving and sharing of sustainable solutions. These include quarterly virtual meetings and an annual agency-wide face-to-face meeting with innovative tours, both of which include guest speakers and site assistance visits.
- Collaboration was enhanced through improved Agency websites, hosting a series of quarterly employee training opportunities, and maintaining the NASA Environmental Tracking System to facilitate solid waste reporting.
- KSC successfully recycled 7,385 pounds of refrigerant, generating enough revenue to match the revenue from all other recycled commodities in FY 2019. Recycling revenue is applied toward other KSC recycling initiatives and has enabled KSC's recycling program to be self-funded for more than 10 years.
- In FY 2019, JSC posted signage on every paper towel dispenser (~900) to educate employees on how to more effectively use a single paper towel. Paper towels are the most common non-hazardous, non-C&D waste item on the campus.

Priority Strategies & Planned Actions

For FY 2020, NASA is electing to retain its internal goal of 50%, recognizing that waste generation and diversion rates are likely to be substantially affected by the lack of standard office operations during the pandemic. The Agency will use several strategies, initiatives, and actions to support and improve hazardous and non-hazardous waste reduction efforts at NASA Centers:

- Provide technical resources and program implementation support to community-of-practice members across the Agency, focusing on waste reduction strategies including source reduction, reuse, recycling, composting, and energy recovery.
- Help improve Center recycling programs by identifying and exploring new opportunities. For example, in FY 2020, KSC's environmental office is purchasing an electric cart designed to deploy up to 120 portable recycling containers at large Center events, including launch viewing venues. A clear bag placed in a collapsible frame and labeled with acceptable recyclables will be staged next to each trashcan. This program will raise recycling awareness and participation.
- Improve Agency web-based collaborative tools and create a variety of opportunities for training, problem solving, and knowledge sharing.
- Use EMS to assess opportunities to further improve waste reduction at the Centers.

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Implementation Summary: Fleet Management

7. TRANSPORTATION / FLEET MANAGEMENT

FY 2019 Petroleum Reduction Progress (Gal):
77.6% reduction in petroleum fuel since 2005
16.8% reduction in petroleum fuel since FY18

FY 2019 Alternative Fuel Use Progress (Gal):
37.2% reduction in alt fuel since 2005
24.9% reduction in alt fuel since FY18

FY 2020-FY 2021 Plan:
10% reduction in FY20 from FY19
0% reduction in FY21 from FY20

FY 2020-FY 2021 Plan:
0% increase in FY20 from FY19
0% increase in FY21 from FY20

NASA’s Fleet Management Plan uses several strategies to improve fleet efficiency, most notably right-sizing the fleet and acquiring specialized vehicles during end-of-lifecycle replacements.

Implementation Status

NASA continues to exceed its goals for reduction of petroleum fuel use. The Agency used several strategies to support and maintain its aggressive execution of its Fleet Management Plan:

- Optimize use of the vehicle fleet.
- Acquire and/or adjust the size and functional utility of each vehicle to match the program’s needs and/or mission’s requirement (right-sizing the vehicle fleet).
- Acquire alternative fuel vehicles (AFV), flex fuel vehicles (FFV), low greenhouse gas (GHG) emitting and zero emission vehicles during end-of-lifecycle replacements.

NASA’s transportation fleet is right-sized to the optimal number of transportation assets.

NASA continues its Vehicle Utilization Review Board (VURB) process of reviewing and evaluating vehicle requirements for both existing and new requests. The vehicle inventory adjusts with NASA’s administrative or mission changes to remain in line with appropriated funding approvals or upon reaching program or contracting milestones. Vehicle assets are reviewed and validated annually to ensure vehicle requirements are properly allocated and utilized based on those approved program or mission requirements. VURB reviews ensure ongoing right-sizing of the NASA fleet, allowing NASA to identify end-of-life vehicle assets and consider opportunities for optimal AFV, FFV, low GHG and/or zero emission replacement selections. NASA’s VURB meets all the requirement of the General Services Administration Vehicle Allocation Methodology.

NASA’s end of FY 2019 fleet assets consisted of 2,716 assets, including 198 low speed electric vehicles, 334 sedans, 1,370 light duty trucks (including vans), 482 medium duty trucks, 311 heavy duty trucks, and 21 ambulances. This represents a total reduction of 1,276 vehicle assets since FY 2005 and a reduction of 161 vehicle assets compared to FY 2018. The number of alternative fueled vehicles increased from 871 in FY 2005 to 1,466 in FY 2019.

As a result of reducing the number of vehicles, right-sizing each asset to be the smallest, most fuel efficient to meet the mission, and selecting more low emission petroleum fuel vehicles, consumption numbers have shifted down, reducing both petroleum and alternative fuels use. In today’s world, many smaller, very fuel-efficient petroleum vehicles outperform alternative fueled vehicles in both miles per gallon and emission standards; NASA’s investment strategy favors selection of vehicles based on fuel efficiency and low emissions.

Priority Strategies & Planned Actions

The Agency will continue investment and development of NASA’s Fleet Information Management System (FIMS) to improve data and cost information of the Fleet. Coding updates to NASA’s FIMS are required by the Federal Automotive Statistical Tool (FAST) for compliance so that formatting acceptable data files will ensure cost and data information can be transmitted electronically from NASA to the FAST system via Vehicle Level Data, saving hundreds of work hours compared to manual cost and data record keeping and reporting.

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NASA expects to see further reductions in petroleum fuel consumption during FY 2020. The impact of COVID-19 has limited eight Centers and four Component Facilities to mandatory telework for all non-mission-critical personnel. These Centers and Component Facilities will greatly reduce normal operation of fleet assets during mandatory telework requirements. The reduction in fleet use will be positively reflected in meeting goals for petroleum reduction (and GHG reduction); however, it will not be due to improved efficiencies but rather to the non-use of assets. It is not possible to estimate the total impact on petroleum use until Centers are reopened for full occupancy.

The lack of fleet use will have a negative impact on the goal of increasing the use of alternative fuel. The non-use of fleet assets will reduce the total number of gasoline gallon equivalences of alternative fuel consumed. Based on the fact that NASA's current alternative fuel use equals 15.0% of its total fuel use, NASA would not expect to meet the annual goal of increasing alternative fuel during FY 2020. NASA recently completed its vehicle replacement order for FY 2020 and in accordance with the Fleet Management Plan, placed orders for an increasing number of low emission petroleum vehicles. Together the lack of fleet use and the future replacement of current alternative fueled vehicles with low emission emitting petroleum vehicles will greatly limit NASA's use of alternative fuel during FY 2020.

Implementation Summary: Cross-Cutting Operations

8. SUSTAINABLE ACQUISITION / PROCUREMENT

FY 2019 Sustainable Acquisition Progress:

16.4% of contract actions and 18.8% of obligations (in dollars), for a total of \$2,708 million in contract actions with statutory environmental requirements

FY 2020-FY 2021 Plan:

17% of contract actions and 19% of obligations (in dollars)

18% of contract actions and 20% of obligations (in dollars)

NASA will comply with statutory requirements and increase acquisition of sustainable products and services. It will accomplish this through a combination of training of acquisition personnel and monitoring the contracting process.

Implementation Status

In FY 2018 and 2019, NASA continued to use several avenues to support and improve sustainable acquisition efforts. Centers routinely provide sustainable acquisition training for their employees. For example, employees who use the government purchase card system receive training every three years. The NASA RSA team provided technical resources and program support in several ways:

- Conducted sustainable acquisition (SA) training sessions for NASA contracting personnel in the Research Center Policy Group, which included four NASA Centers in FY 2018 (AFRC, ARC, GRC, and LaRC).
- Provided SA training sessions for NASA contractors at NASA Centers in FY 2018 (KSC, LaRC, and WSTF) and in FY 2019 (GRC and MSFC).
- Provided input for government purchase card procedures and instructions, and the associated module in NASA's internal web-based training system (FY 2018–2019).
- Facilitated distribution of purchase card reports to help Centers better track what is being purchased at their Centers and to identify areas of improvement for sustainable acquisition (FY 2018–2019).

Several NASA Centers participated in U.S. Department of Agriculture BioPreferred product evaluations, deploying biobased products within transportation, fleet, lawn maintenance, and heavy equipment operations. In FY 2019, NASA's top five biobased procurements included paper products, artificial turf, plastic bags, disposable tableware, and packaging and insulation. In FY 2019, NASA had 149 biobased contract actions totaling \$115,604,357.90.

Center procurement officers will continue to perform activities to improve sustainability clauses in contracts:

- Examine the Environment/Sustainable Acquisition sections of a NASA form completed by the intended acquisition end users and submitted with each request for a new purchase order or contract, to monitor for sustainability requirements.

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- Perform additional pre-solicitation and pre-award contract reviews, including use of sustainability requirements.

The Headquarters Office of Procurement (HQ OP) regularly inspects NASA Center procurement operations for adherence to procurement regulations, efficiency, and effectiveness. These inspections were postponed for a year due to internal NASA reorganization activities but are expected to restart in June 2020. These Performance Management Reviews (PMR) include several actions:

- Evaluate sustainable solicitation provisions and contract clauses actually included within solicitations and contracts.
- Identify root causes of any issues found in the PMRs and propose potential corrective actions.
- Provide support to improve acquisition and acquisition reporting efforts.

Priority Strategies & Planned Actions

RSA will continue to perform the following activities:

- Provide training sessions for NASA contractors and contracting office personnel.
- Provide input for NASA purchase card procedures and instructions, as well as the associated training module.
- Facilitate distribution of purchase card reports to identify areas of improvement for sustainable acquisition.
- Collaborate with DoD and the Defense Logistics Agency to participate in upcoming sustainable technology demonstration projects at NASA Centers to evaluate biobased cleaner, lubricant, and preservative for weapons; renewable diesel fuel; biobased sorbents; and energy-efficient door systems.

Center procurement offices will continue to conduct activities:

- Review the Environmental/Sustainable Acquisition sections of forms completed by the intended acquisition end users to determine compliance with sustainability requirements.
- Perform additional pre-solicitation and pre-award reviews, including use of sustainability requirements.

HQ OP will continue to use the PMRs, performed at each NASA Center on a three-year review cycle, to inform development of specific training tailored to spur continuous improvement at each Center in FY 2020.

HQ and RSA will work together to ensure that Federal Procurement Data System (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.

NASA set a FY 2020 target of 160 biobased-only contract actions, with an estimated \$100 million dollar value.

9. ELECTRONICS STEWARDSHIP

FY 2019 Electronics Stewardship Progress:

100% of newly purchased or leased equipment met energy efficiency requirements

100% of electronic equipment disposed using environmentally sound methods*

**Reuse, donation, recycling, transfer, sale, or demanufacturing.*

NASA standards for minimum hardware compliance, IT-07 and NASA-STD-2805, enforce responsible stewardship compliance by maintaining standards that include procuring from sources that practice environmentally sound practices. Compliance includes procurement of Electronic Product Environmental Assessment Tool (EPEAT)-Gold products, which meet Federal energy efficiency requirements, as well as Energy Star certified devices.

Implementation Status

NASA continues to ensure procurement preference for EPEAT Gold-registered products; maintain policies to enable power management, duplex printing, and other energy-efficient features; employ environmentally sound practices with respect to the disposition of electronic products; and procure Energy Star and FEMP-designated electronics.

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Priority Strategies & Planned Actions

NASA implements an Agency-wide enterprise contract that contains energy efficiency clauses for the purchase and maintenance of desktops, laptops, network printers, multifunction devices, and other computing devices. NASA will continue to implement standardized configurations to manage and monitor energy efficiency settings as well as ensure efficiencies in desktop service functions, costs, and compliance with federal initiatives. The normal refresh cycle for the Agency Consolidated End-User Services enterprise contract for procured office automation equipment will be maintained, ensuring 100% compliance with EPEAT standards. NASA will continue to ensure all NASA Enterprise IT Support and Services contracts contain clauses on environmentally sound practices for disposition of all Agency excess or surplus equipment.

10. GREENHOUSE GAS EMISSIONS

FY 2019 Scope 1&2 Greenhouse Gas (GHG) Emissions:

37.6% reduction from FY 2008

1.5% increase from FY 2018

NASA manages GHG emissions through cost-effective strategies in line with other Sustainability Plan goals to support its mission. Scope 1&2 efforts include investing directly in more efficient equipment and renewable energy, performance contracting, replacing or renewing inefficient legacy buildings, and transportation fuel management. For the largest emission source, Scope 2 purchased electricity, emissions have decreased by nearly 45% since FY 2008. As compared with the prior year, an uptick in more mission-variable Mobile and Fugitive sources resulted in a Scope 1&2 emissions increase of approximately 1.5% in FY 2019.

Implementation Status

NASA has achieved significant GHG emission reductions since the FY 2008 baseline through a combination of project initiatives spanning many areas discussed above, as well as by alternative modes of commuting. Transportation goals play a role in driving Scope 1 emission reductions for the Agency, such as through ongoing fleet management. NASA has also undertaken more progressive strategies. For example, KSC's pilot *Catch-A-Ride (KCAR) Ride Share Initiative* helps achieve several objectives:

- Minimize single-driver trips in Agency vehicles between distant operational areas on-site.
- Track utilization rates and progress on Scope 1 transportation emission reductions by utilizing a web application to arrange trips and collect data.
- Potentially reduce Scope 3 emissions by incentivizing less individual commuting in personal vehicles.

Major facility investments also help to drive reductions in the largest emissions category of purchased electricity consumption. Projects such as JSC's combined heat and power (CHP) plant have provided a significant net reduction in emissions; however, understanding the full project impact involves two key considerations:

- The project decreases *net* Scope 1&2 emissions. While the CHP increases on-site Scope 1 stationary combustion emissions, the Scope 2 purchased electricity emission reduction is greater in magnitude.
- Transparent accounting of the full emission reduction impact and holistic environmental benefit requires a review of how on-site power production has eliminated emissions associated with grid transmission and distribution losses, a Scope 3 emission category.

Priority Strategies & Planned Actions

Further GHG reduction opportunities become incrementally more challenging each year, as the Agency has implemented many of the low-hanging fruit projects that drive down emissions. This is evidenced by the small uptick of GHG emissions in FY 2019 compared with FY 2018. For FY 2020 and FY 2021, the Agency is researching how a few innovative methods could help maintain consistent Scope 1&2 GHG emission reductions into the future. Potential use of cutting-edge battery and carbon capture and sequestration technologies, for example, could become part of future strategic GHG management in coordination with facility energy goals.

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Commuting emissions remain NASA's largest Scope 3 emission source, and Agency telecommuting initiatives have helped promote operational readiness by preparing for remote interaction capabilities. NASA envisions helping to facilitate multi-agency discussions on best practices for applying this data in a manner that serves mission, sustainability, efficiency, and cost reduction goals.

Agency Highlights

Pollinators Converge on Marshall Space Flight Center

To increase habitat quality and availability, MSFC established a pollinator habitat with more than 160 plants to attract butterflies, hummingbirds, and other pollinators. The habitat also serves as an educational tool to increase understanding of pollinator health and the critical role that native plant species play in the pollinator lifecycle.

The MSFC Green Team coordinated with Northern Alabama Master Gardeners to plot the habitat layout, design the drip irrigation system, and select plants that would enhance pollinator populations throughout the growing season. The plants, mostly perennials, are drought tolerant and require minimal upkeep. Many of the plants were grown from seed by MSFC Green Team members. Regional Plant nurseries donated large trees and shrubs to anchor the garden. Notably, the habitat was created without any appropriated funds and is maintained by volunteers.

Still Reducing, Reusing, and Recycling

The EPA recognizes federal facilities for conserving resources and saving taxpayer money as part of their Federal Green Challenge. In FY 2019, WSTF was recognized by the EPA for their efforts in saving resources and reducing waste. WSTF personnel developed an application called Reuse Market Place (ReMaP) for employees to post available items for other departments to reuse, such as furniture, supplies, and chemical products. ReMaP has helped save over \$66,000 and diverted 22,000 tons of materials from the landfill since February 2017.

MSFC's New Administrative Office Building 4221 Earns Dual Recognition

Architects designed this new office building to obtain a LEED Silver rating from the USGBC and two Green Globes from the Green Building Initiative. Close coordination and teamwork among the design team, construction contractor, and MSFC provided the opportunity for the building to receive additional points and achieve three Green Globes. This is MSFC's ninth certified green building. Building 4221 reduces energy costs by approximately 32% through an improved building envelope, LED lighting, and controls. Interior water usage is reduced by approximately 30% through using highly efficient plumbing fixtures. A 20,000 gallon cistern collects rainwater from the roof, which is reused for irrigation of the building's landscaping. Its cooling equipment uses refrigerants that have zero or near-zero ozone depleting chemicals. Approximately 92% of the wood used in construction came from Forest Stewardship Council-Certified forests. During construction, 78% of waste was diverted from landfills; approximately 25% of total construction materials contain recycled content. The 120kW rooftop solar array provides on-site renewable energy. Building occupants report that their favorite feature is a five-story atrium, which provides daylighting to the interior of the building and a wonderful view to the head of MSFC's greenway.

Reducing Cafeteria Waste at Several NASA Centers

NASA looks for creative solutions to keep cafeteria waste out of the landfill through reusable containers, composting, FoodCyclers, pulpers and more. Some initiatives include the following:

- WSTF's Green2Go project was launched in its cafeteria on Earth Day 2019. This waste reduction initiative provides reusable takeout containers in the cafeteria. Each BPA-free container can be reused up to 500 times, reducing the Styrofoam™ containers distributed by 28,000 over the life of the project.
- ARC is responsible for the majority of the 391,152 lbs of food and biodegradable cafeteria products composted in FY 2019. The Center stocks 100% compostable materials in all of its cafeterias.
- KSC Visitor's Complex diverted 76,300 lbs of kitchen food waste from the landfill using a FoodCycler. The process grinds, heats, and decomposes the waste to 1/10 of the original weight. In the future, the organic residual may be used as a nutrient-rich soil amendment.

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- LaRC uses a food pulping process which reduces the kitchen food and paper waste by 75% and reduces water use. Kitchen food and paper waste (napkins, cups, and paper items) are rinsed off and pulverized, the rinse water is recycled, and the pulverized waste is discarded. The final residual liquid is released to the sanitary sewer. LaRC's cafeteria also has a discount policy for drink refills to motivate customers to bring personal or reusable cups. A plastic dispenser system encourages customers to take only needed utensils and Styrofoam™ containers are used only for hot food or by request.