

**National Aeronautics and Space Administration's
Annual Report to the Department Of Energy
for Fiscal Year 2001**

This document contains the National Aeronautics and Space Administration (NASA) annual energy report to the Department of Energy (DOE) and the Office of Management and Budget (OMB). It is provided as the Agency's input to the Annual Report to Congress for Fiscal Year (FY) 2001 as required by the National Energy Conservation Policy Act (NECPA), as amended, and Executive Order (EO) 13123. This report contains quantitative energy and facilities information required by DOE and OMB, as well as narrative descriptions of significant accomplishments by NASA Headquarters and Centers during FY 2001. This report is based on the best information available at the time of preparation.

I. Management and Administration.

A. Energy Management Infrastructure.

1. **Senior Agency Official.** The NASA Administrator designated Mr. Jeffrey E. Sutton, Associate Administrator for Management Systems (Code J), as the senior NASA official responsible for meeting the goals and requirements of EO 13123. Mr. Sutton is responsible for providing Agencywide executive and functional leadership, oversight, guidance, coordination, and advocacy for Agency logistics, industrial relations, facilities, environmental management, and energy efficiency programs, aircraft management, ISO 9001 quality systems, NASA Employee Exchanges, and management policy directives, systems, and controls. Mr. Sutton also represents NASA on the Interagency Energy Policy "656" Committee.

2. **Agency Energy Team.** The Energy Efficiency Board (EEB) was established to meet the requirement for an Agency Energy Team. The EEB provides an Agency-level forum to guide the planning and implementation of energy efficiency activities, including energy and water conservation, greenhouse gases reduction, and use of renewable energy sources. In this capacity, the EEB:

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Supports development of Agency energy efficiency policy, leadership strategy, and annual implementation plans required by Executive Order 13123.

Sponsors studies and assessments of energy efficiency issues and recommend initiatives deemed beneficial and value added to the Agency.

Supports Center Directors in implementing NASA energy efficiency policy and advance the use of appropriations, Energy Savings Performance Contracts (ESPCs) and other alternative financing mechanisms necessary to meet Federal energy efficiency goals.

Develops consensus positions on energy efficiency priorities, practices, and issues across Agency and Enterprise activities.

EEB membership includes the following:

Director, Environmental Management Division, Chair. •

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Director, Facilities Engineering Division, Acting Chair in the absence of the Director, Environmental Management Division.

NASA representative to the Interagency Energy Management Task Force, Executive Secretary.

Senior representatives from each Enterprise Institutional Program Office, the Office of the Chief Financial Officer, the Office of Headquarters Operations, and the Office of Procurement.

The Facilities Director of each NASA Center and Component Facility as supported by the designated Energy Manager.

The General Counsel, or designee, as a non-voting advisor to the EEB.

The EEB reports to the Associate Administrator for Management Systems, as the senior Agency official responsible for meeting Federal energy efficiency goals and requirements. EEB work products and recommendations are presented to the Associate Administrator for Management Systems for concurrence

or approval, as required. The EEB also prepares analyses and recommendations for the NASA Capital Investment Council as appropriate.

B. Management Tools. NASA employed the following management initiatives and tools to promote effective energy and water management:

- A comprehensive new NASA directive entitled “NPG 8570.1, Energy Efficiency and Water Conservation Technologies and Practices” was issued on March 15, 2001. This directive provides Agencywide procedures and guidelines for meeting the requirements and goals of EO 13123, using alternative financing, and evaluating renewable energy and water conservation opportunities.
- Program Operating Plan guidance was issued to NASA Centers and Component Facilities for including energy efficiency funds in their FY 2003 budget requests.
- The NASA Headquarters Environmental Management Division conducted Energy and Water Management Functional Reviews at Ames Research Center, Dryden Flight Research Center, Johnson Space Center, White Sands Test Facility, and Kennedy Space Center.

1. Awards (Employee Incentive Programs). NASA is developing an Agency Environmental/Energy Awards Program to recognize accomplishments in implementing all of the *Greening the Government* Executive Orders. The Award Program will be implemented in FY 2002. NASA continues to be an active participant in the DOE Federal Energy and Water Management Awards program. In addition, most NASA Centers and Component Facilities recognize employee contributions to energy and water savings by utilizing established employee suggestion programs, issuing monetary awards based on savings achieved, and recognizing employee contributions in internal news publications. The following specific activities were pursued:

NASA submitted five nominations for the 2001 Federal Energy and Water Management Awards. The NASA Energy Team’s work in achieving “Federal Energy Management Success” was selected for the 2001 Presidential Award for Federal Energy Management.

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NASA Centers and Component Facilities used established beneficial suggestion programs to encourage and reward employee involvement in energy conservation.

NASA named three new *Energy Champions* in FY 2001, for a total of 19 NASA *Energy Champions* since the DOE Federal Energy Management Program (FEMP) initiated this program in FY 1998. The Ames Research Center administered Pollution Prevention awards that include energy conservation. Cash awards are given to winners.

The Kennedy Space Center Environmental Program Branch created two new award programs for Center employees and contractors. The *Catch an Environmentalist Award* is a quick recognition program managed by the Environmental Program Office to reinforce positive behaviors. Winners receive a framed cloth environmental logo. The *Environmental & Energy Award* is a biannual competition conducted by Center Awards Office. This award recognizes significant achievements in all areas of environmental and energy management. Award winners receive a certificate with a patch flown on the Space Shuttle that is presented by the Center Director. The Kennedy Space Center Joint Base Operations Support Contractor established the Energy Achievement Goals for Life and Environment (EAGLE) Award program to recognize employee contributions to energy and water efficiency and environmental improvement. During FY 2001, two \$250 savings bonds, certificates, and EAGLE pins were awarded for installing a boiler automatic blow down system and a new high efficiency compressed air dryer.

2. Performance Evaluations. Most NASA Centers and Component Facilities include, or plan to include, the successful implementation of energy management conservation requirements in performance evaluations and positions descriptions for all those involved in energy management activities. This practice extends to many Center Operations Support Services contractors.

3. Training and Education. NASA completed the following activities to ensure that that all appropriate personnel receive training for energy and water management requirements:

- An Energy Efficiency and Water Conservation (EEWC) course was developed to give

energy and facilities management professionals the knowledge and skills required to successfully implement energy efficiency and water conservation projects. The pilot course was held on December 11-15, 2000, at NASA's Management Education Center at Wallops Island, Virginia. There were 25 participants.

- Ten NASA employees and on-site support contractors from four locations attended Energy 2001 in Kansas City. Two of these individuals gave presentations at the Conference on ESPC lessons learned and NASA's solar-powered aircraft program.

- Kennedy Space Center carried the DOE FEMP and ASHRAE 90.1 broadcasts on the Center's closed circuit TV system.

- Several NASA Centers hosted employee energy awareness activities as part of October Energy Awareness Month and Earth Day observances.

- The NASA Energy Coordinator received a 2001 Federal Energy Management Award for his participation in DOE FEMP's highly successful *You Have the Power* energy awareness campaign.

- NASA Headquarters began broadcasting recurring energy conservation messages to all employees via the Headquarters Information Television closed circuit system.

- In all, approximately 70 NASA employees and contractors received energy and water management training through NASA- and DOE FEMP-sponsored courses, industry conferences, and commercial or academic sources.

4. Showcase Facilities. NASA designated the Aircraft Maintenance Hangar Building 1623, at Dryden Flight Research Center, as a Showcase Facility. This building features a hybrid solar/modular gas-fired boiler heating system, consisting of a 2,500 square foot transpired solar wall and six modular high-efficiency condensing boilers. In replacing the oversized and inefficient aircraft hangar heating system, NASA simultaneously improved indoor air quality, reduced greenhouse gas emissions, and saved energy. Emissions reductions were so significant that the boilers no longer require expensive air permitting. Building 1623 is NASA's second showcase facility, the first being the Marshall Space Flight Center Project Engineering Facility, Building 4203, designated in FY 1996.

II. ENERGY EFFICIENCY PERFORMANCE

A. Energy Reduction Performance. In FY 2000, NASA realigned its facility designations and historical energy consumption baselines to comply with the definitions and goals established by EO 13123 for the three new categories of Federal buildings and facilities. These categories are: Standard buildings/facilities subject to Section 202, Energy Efficiency Improvement Goals.

NASA refers to these as Nonmission Variable (NMV) buildings.

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Industrial, laboratory, research, and other energy-intensive facilities subject to the goals of Section 203, Industrial and Laboratory Facilities. NASA refers to these as Energy-Intensive Facilities (EIF).

Exempt facilities as defined under Section 704. NASA refers to these as Mission Variable (MV) facilities. A summary of pre-and post-EO 13123 facility designation categories for each NASA Center and Component Facility is show in the table below:

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Ames Research Center (ARC) X X X X X X

Dryden Flight Research Center (DFRC) X X

Glenn Research Center (GRC) X X X X X X

Plum Brook Station (PBS) X X

Goddard Space Flight Center (GSFC) X X X X X X

Wallops Flight Facility (WFF) X X X X

Jet Propulsion Laboratory (JPL) X X X X

Johnson Space Center (JSC) X X X X X

White Sands Test Facility (WSTF) X X X X

NASA Industrial Plant (NIP) Downey/Palmdale X X

Santa Susana Field Laboratory (SSFL) X X

Goldstone Deep Space Network (DSN) X X

White Sands Complex (WSC) & Other Tracking Stations X X

Kennedy Space Center (KSC) X X X X
Langley Research Center (LaRC) X X X X X X
Marshall Space Flight Center (MSFC) X X X X
Michoud Assembly Facility (MAF) X X
Stennis Space Center (SSC) X X

Center/Component Facility

Before EO 13123

Facility Energy

Categories

After EO 13123

Facility Energy

Categories

NMV

Exempt

MV NMV EIF

Exempt

MV

Exempt

Wind Tunnels

Minor corrections to NASA's historical energy consumption and cost data reported last year for FY 1985 through FY 2000 are required to bring DOE FEMP's database into alignment with the NASA Environmental Tracking System (NETS) database and individual Center records. Corrected Annual Energy Management Data Reports for FY 1985 through FY 2000 are provided in Appendix A. These changes improve the accuracy of NASA's annual report to DOE and facilitate communication of energy conservation progress between Headquarters and the Centers.

Appendix A also contains NASA's Energy Management Data Report for FY 2001 through FY 2003. This report is based on the best information available, but much of the required information cannot be accurately quantified and must necessarily be based on estimates.

Appendix D contains a listing of NASA's Industrial and Laboratory, or EIF, facilities. Appendix E contains a listing of individual MV facilities for which NASA requests exemption from the energy reduction goals under Section 704. Justifications are provided for each exempt MV facility to explain why it is either technically infeasible to implement energy efficiency measures or to apply conventional performance measures due to the overwhelming proportion of process-dedicated energy consumed in these facilities.

1. Standard Buildings. The average energy intensity for NASA's standard buildings was 212,099 BTU per GSF by the end of FY 2001, as compared to the FY 1985 baseline value of 257,131 BTUs per GSF. This represents a 17.5 percent decrease. See the NASA FY 2001 Energy Scorecard (Appendix B) and the Annual Energy Management Data Reports for FY 1985 through FY 2002 (Appendix A) for further detail.

2. Industrial and Laboratory Facilities. Appendix D identifies the NASA facility inventory subject to the Industrial and Laboratory, or EIF, energy reduction goals. NASA has elected to use BTU per GSF as the Agencywide aggregate performance measure for these facilities.

However, NPG 8570.1 establishes other performance measures, such as BTU per Production Unit per Degree-Day, BTU per Tracking Hour, and BTU per Gross Cubic Foot for individual industrial facilities, space flight tracking stations, and clean rooms.

The average energy intensity for NASA's standard buildings was 244,640 BTU per GSF by the end of FY 2001, as compared to the FY 1990 baseline value of 323,971 BTUs per GSF. This represents a 24.5 percent decrease. See the NASA FY 2001 Energy Scorecard (Appendix B) and the Annual Energy Management Data Reports for FY 1985 through FY 2002 (Appendix A) for further detail.

NASA continued its shared energy savings contract incentive arrangement with Lockheed Martin Michoud Space Systems (LMMSS), the contractor operator of the NASA Michoud Assembly Facility that

manufactures the Space Shuttle External Tank. NASA rewards LMMSS for exceptional performance in managing energy use by sharing 8 to 14 percent of energysavings achieved as an additional award fee. NASA's share of the savings are used to reduce the overall cost of the Space Shuttle External Tank program. In FY 2001, Michoud Assembly Facility used 864.5 billion BTU to produce 6.0 External Tanks, or 144.8 billion BTU per External Tank, compared with 203.5 billion BTU per External Tank in FY 1990. This represents a 28 percent decrease in energy consumption per External Tank produced.

3. Exempt Facilities.

Appendix E identifies NASA's exempt MV facilities. In FY 2001, only 4,991,145 GSF, or 12.5 percent of NASA facility square footage is designated as exempt. These facilities are highly specialized and energy intensive, having been constructed for specific space flight and research programs. Examples are wind tunnels driven by multi-thousand horsepower electric motors, space simulation chambers, and space communication facilities. The facilities range from pre-World War II aeronautical test installations to new facilities that support the Space Shuttle and International Space Station programs. Energy consumption in these facilities varies directly with the level and intensity of program activities. Concise justifications are provided for each MV facility exemption to explain why it is either technically infeasible to implement energy efficiency measures or to apply conventional performance measures due to the overwhelming proportion of process-dedicated energy consumed in these facilities.

NASA adopted an internal goal to improve the energy efficiency of exempt MV facilities, where cost effective and without adversely affecting mission performance, by 10 percent by FY 2005 compared with FY 1985 levels. Due to the unique nature of their design and operation, wind tunnels are excluded from this goal.

4. Tactical Vehicle and Equipment Fuel Use. Data for bulk fuels delivered to NASA for use in NASA-owned aircraft, on- and off-road vehicles, and other mobile and stationary equipment is reported in Appendix A. This data does not include off-site fuel purchases nor fuel consumed in vehicles leased from the GSA Interagency Fleet Management System.

NASA completed the following activities to reduce the use of gasoline and diesel fuels in vehicles:

The Merritt Island Launch Annex converted a Ford F-800 high lift truck to compressed natural gas operation.

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Ames Research Center initiated discussions with Pacific Gas and Electric and other local agencies to share costs for construction of a compressed natural gas vehicle fueling station. Glenn Research Center and Kennedy Space Center continued operation of on-site compressed natural gas fueling stations.

B. Renewable Energy.

1. Self-generated renewable energy. NASA's use of self-generated renewable energy is not directly metered, but the quantity produced is negligible. Projects generating an estimated 10.3 megawatt-hours of electricity were completed in FY 2001.

2. Purchased renewable energy. NASA has focused its efforts on purchasing renewable energy from sources that are cost-competitive with conventional energy sources. NASA completed the following activities to increase energy purchases from renewable sources: Goddard Space Flight Center continued working with Toro Energy of Maryland to bring a landfill methane supply pipeline to the Center. A 10-year utility supply contract was awarded to Toro Energy in FY 2000, but the contractor is experiencing delay in obtaining easements needed to construct the pipeline. Delivery of landfill methane to the Center's central boiler plant is expected to begin in FY 2002.

Johnson Space Center awarded a new natural gas supply contract to Entex that will take

effect in FY 2002. Two percent of the natural gas supplied to the Center will come from renewable landfill methane at no additional cost to NASA. The Center is also working with Defense Energy Supply Center (DESC) on a new electricity supply contract for the Center when deregulation begins in Texas on January 1, 2002. The Center may receive up to 5 percent of the electricity from new renewable sources, primarily wind and hydropower, when the final DESC contract is awarded. Langley Research Center and Marshall Space Flight Center continued to purchase steam generated from municipal solid waste.

3. Mission Solar Roofs (MSR). NASA completed one MSR project in FY 2001. A 5.5 kW photovoltaic power system was installed on the roof of Space Sciences Building N-245 at Ames Research Center. The project cost \$60,000 including \$20,000 in public benefits funds from the City of Palo Alto. This project is NASA's second MSR project to date.

C. Petroleum. NASA reduced facility petroleum use by 54.5 percent since FY 1985. Petroleum, including fuel oil and liquefied petroleum gas, represents only 10.4 percent of facility fuel use and 3.8 percent of total facility energy usage.

D. Water Conservation. NASA used 2,487 million gallons of potable water in FY 2001, compared with 2,343 million gallons in FY 2000, a 6.1 percent increase. This increase is possibly due to incomplete FY 2000 baseline data reported by two NASA Centers. NASA will continue to track water consumption data to determine the actual trend, which cannot be determined with certainty with only two years of historical data.

III. Implementation Strategies.

A. Life-Cycle Cost Analysis. Projects and surveys are proposed by the energy manager at each Center and Component Facility. The projects and surveys compete for funding along with other Center requirements. To compete successfully, projects having energy conservation as their sole purpose must have relatively short amortization periods since construction funds are very limited and there are many other high priority projects competing for funding. Life-cycle costing is the primary tool for analyzing energy retrofit projects. Economic analyses are performed for all construction and revitalization projects in excess of \$1,500,000 in accordance with OMB Circular No. A-94. This requirement is established by NASA Policy Directive (NPD) 8820.1, "Design and Construction of Facilities."

B. Facility Energy Audits. The Agency is required to complete facility audits for 10 percent of its building square footage each year beginning March 1994. NASA Headquarters provided guidance to Centers and Component Facilities indicating the level of auditing that will be required for different types of facilities, recommendations on which mission variable facilities could benefit from comprehensive audits, and suggested criteria for determining audit priorities.

Using this guidance, Center energy managers developed plans to perform the audits. During FY 2001, NASA completed audits for 9.6 percent of its total building square footage, including comprehensive audits covering 3,837,726 gross square feet and walk-through audits covering 1,113,698 gross square feet. Among these were two DOE FEMP-sponsored Assessment of Load and Energy Reduction Techniques (ALERT) audits for Dryden Flight Research Center and the Goldstone Deep Space Network Communications Complex. From FY 1991 through FY 2001, NASA completed comprehensive energy audits for 86.7 percent of its total building square footage, including 79.7 percent of non-exempt square footage, and 94.4 percent of exempt and industrial square footage.

C. Financing Mechanisms. NASA made continued progress in implementing ESPC and UESC contracts. To date, NASA has awarded six ESPC delivery orders and four UESC at five Centers (Ames Research Center, Glenn Research Center, Goddard Space Flight Center, Johnson Space Center, and Kennedy Space Center), and participated in DOD-managed ESPC and UESC contracts at two Centers (Dryden Flight Research Center and Kennedy Space Center). These actions have resulted in \$36.6 million in energy improvements for NASA facilities that are saving \$4.6 million annually. These totals include the following FY 2001 accomplishments:

- Goddard Space Flight Center issued its third ESPC delivery order under its own multiple award indefinite delivery, indefinite quantity (IDIQ) ESPC contracts with two Washington, DC area small, disadvantaged energy service companies, Enviro-Management & Research, Inc. of Arlington Virginia and Lord & Company, Inc. of Manassas, Virginia. This \$425,000 delivery order installed lighting system upgrades in five buildings. The Center elected to buy-out the contract after the work was completed. Annual savings of \$55,000 are anticipated.
- Goddard Space Flight Center also issued a UESC contract to PEPCO Energy Services to install two 500-foot potable water wells. The wells will supply 7,000,000 gallons of make-up water to the Center's cooling towers. The \$854,000 project will reduce demand on the local water utility's potable water supply. The Center elected to buy-out this contract after construction was completed. Annual savings of \$350,000 are anticipated from reduced utility costs
- Kennedy Space Center issued its second UESC contract to FPL Services for \$2.5 million in energy efficiency improvements to Space Shuttle facilities. The project includes heating, ventilating, and air-conditioning (HVAC), lighting, and compressed air system upgrades that will save \$358,000 annually. The project also qualified for \$41,000 in utility incentives.
- Jet Propulsion Laboratory, a Federally Funded Research and Development Center in Pasadena, California, continued work on its own commercial-type ESPC contract. The Laboratory received a preliminary proposal from Sempra Energy Solutions that could potentially be NASA's largest ESPC to date. Sempra proposed \$22.5 million in energy improvements that would save approximately \$3 million annually. The proposal includes a 6.3 megawatt combined heat and power system, microturbines, lighting upgrades, variable speed drives, water conservation measures, and natural gas submetering. Laboratory management has given approval for Sempra to proceed to the detailed audit phase.

D. Energy Star ® and Other Energy-Efficient Products. NASA Centers and Component Facilities are actively procuring energy efficient goods and products that are the most life-cycle cost-effective, pursuant to the requirements of the Federal Acquisition Regulations. In FY 2001, NASA Centers and Component Facilities continued to install high efficiency electrical products such as variable frequency drive systems for fans and pumps, high efficiency fluorescent lamps, electronic ballasts, compact fluorescent lamps as replacements for incandescent bulbs, light emitting diode (LED) and other low power consumption exit lights, and occupancy sensors.

NASA took the following actions in FY 2001 to purchase Energy Star ® and other energy-efficient products:

- NASA Headquarters completed a study to help migrate existing Center Energy Monitoring and Control Systems (EMCS) to the new EMCS open protocol standards (BACnet and LONWORKS).
- NASA Headquarters provided detailed guidance to Kennedy Space Center to incorporate DOE energy-efficient product recommendations into NASA's Specifications-Kept-Intact (SPECSINTACT) construction guide specification system. Kennedy Space Center, as Lead Center for SPECSINTACT, will revise appropriate guide specification sections in FY 2002.
- Jet Propulsion Laboratory began evaluating T-5 fluorescent lamps as higher efficiency alternatives to the T-8 fluorescent lamps now in use.
- Kennedy Space Center awarded a new copier contract that replaced all copiers at the Center with new Energy Star ® duplexing copiers.
- Kennedy Space Center deployed Windows 2000 for all NASA computers at the Center and set the default power-saving mode for monitors to activate after 20 minutes of inactivity. The Space Station/Payloads Processing on-site support contractor found and corrected a software incompatibility between Windows NT and certain video cards that prevented activation of the Energy Star ® low-power standby mode. The problem was corrected with third party software. About 1,900 contractor-owned computer monitors now automatically go into the Energy Star ® low-power standby mode after 30 minutes of inactivity.

E. Energy Star ® Buildings. No new Energy Star ® buildings were designated in FY 2002.

F. Sustainable Building Design. NASA continued development of an integrated sustainable design policy that will combine the traditional sustainability concepts of the Whole Building Design Guide with building commissioning, design for maintainability, safety, and security. A high-level policy directive was drafted and is being routed for Agency approval. Detailed implementation procedures and guidelines are being developed along with a companion in-house training course. Despite lack of an approved Agencywide policy, the Centers continued work on several facility project designs that incorporate sustainable design features. Some examples are:

- The Space Experiment Research and Processing Laboratory at Kennedy Space Center will incorporate an innovative passive storm water retention area, 100 percent native plants with low water requirements, a central light well to bring natural light into the open plan office space, low volatile organic compound paints and coatings, high efficiency lighting with occupancy sensors, variable frequency drives on air handlers, chilled water pumps and cooling towers, high efficiency chillers and passive solar thermal mass principles.

- The Operations Support Building II at Kennedy Space Center is designed to exceed EO 13123 and 10 CFR 435 energy efficiency requirements and will use at least 47 percent less energy than the temporary, modular offices it will replace. The project will incorporate an automatic irrigation system, 100 percent native plants with low water requirements, high efficiency lighting with occupancy sensors and daylight-compensating dimmer controls, variable air volume HVAC systems with variable frequency drives on air handlers and chilled water pumps, and advanced filtration to maintain adequate indoor air quality.

G. Energy Efficiency in Lease Provisions. This strategy is of only minor importance to NASA since leased space represents about 4 percent of NASA's total building inventory.

H. Industrial Facility Efficiency Improvements. NASA completed a number of projects in FY 2001 to improve the energy efficiency of standard and energy-intensive industrial facilities. The majority of projects fall into the following categories:

- 1) HVAC system modernization including replacement of inefficient chillers, installation of variable air volume systems and removal of constant volume, terminal reheat systems.

- 2) EMCS upgrades and expansions to monitor and control heating and cooling apparatus startup and shutdown, fluid temperatures and pumping rates, use of outside air for cooling and ventilation, electrical demand limiting, and optimization of equipment operation.

- 3) Lighting and electrical system efficiency improvements including lighting upgrade, relamping projects, power factor correction, and installation of metering equipment.

- 4) Weatherization, and other energy conservation measures involving the building envelope, including repair and upgrade of roof and wall insulation.

- 5) Metering and monitoring system improvements.

Specific project undertaken in FY 2001 are listed below:

- NASA Headquarters sponsored a continuous commissioning pilot project involving three buildings at Dryden Flight Research Center. The project is being performed under a Cooperative Research and Development Agreement with the Texas Engineering Experiment Station, Energy Systems Laboratory, at Texas A&M University.

- Glenn Research Center completed projects to replace HVAC units, install modern energy controls, upgrade lighting systems, and replace obsolete laboratory fume hood controls in Buildings 14, 15, 54, 77, and various program support facilities.

- Jet Propulsion Laboratory completed various HVAC and lighting retrofit projects at a cost of \$575,000. The projects will save \$87,000 annually.

- Kennedy Space Center replaced the air handlers in several facilities and tied the HVAC systems to the central chilled water plant. This \$175,000 project will save \$18,000 annually. Direct digital controls were installed on the HVAC system in Hangar AE to reduce overcooling and associated reheating of supply air. The \$120,000 project will save \$15,000 annually. The Center initiated a study potential hardware and software solutions to improve collection and access to energy management information. The Center benchmarked the energy metering and monitoring system used by Walt Disney World's Reedy Creek Energy Services as part of the study. The Center also continued efforts to install motion sensors, timers, and programmable thermostats in various facilities.

- The Payloads Processing organization at Kennedy Space Center implemented several low- or no-cost operational changes that are saving significant amounts of energy. Hot water consumption was drastically reduced in the Space Station Processing Facility by changing set points and modifying control algorithms. An ultrasonic BTU meter was installed to measure and record hot water consumption and validate energy savings. Exhaust and conditioned make-up air requirements for the high bay clean work area were reduced by 35,000 cubic feet per minute. Operating procedures were also revised to eliminate the requirement for an “ammonia sweep” mode during special processing operations that required large quantities of conditioned outside air. Together these measures saved \$236,000. Revised standard operating procedures for four other processing facilities allow indoor environmental set points to be relaxed and nonessential HVAC equipment deactivated when space flight hardware was not being processed. This measure saved \$70,000. Energy consumption in the Payload Hazardous Processing Facility and the Vertical Processing Facility was reduced by 40 and 25 percent respectively by reducing the number of HVAC systems operated in support certain missions. Together these measures saved \$60,000.
- The Merritt Island Launch Annex consolidated electrical loads to remove unnecessary transformers from service thereby reducing parasitic losses.
- Langley Research Center completed various facilities maintenance tasks including roofing and HVAC replacement projects at a cost of \$2,448,000. These projects will save \$490,000 annually. The Center also completed a project to improve substation metering used to collect data on power parameters and energy supplied to Langley Air Force Base. The project will provide greater accuracy in billing the Air Force for electrical energy.

I. Highly Efficient Systems. NASA completed the following actions in FY 2001 to develop new construction and retrofit projects for advanced cooling, heating, and power systems: Langley Research Center initiated a Steam Optimization and Utilization Project (SOUP) to identify cost-effective ways to utilize approximately 150 million pounds per year of excess steam that is now being vented to atmosphere at a nearby solid waste energy recovery facility.

- Jet Propulsion Laboratory received a preliminary ESPC proposal from Sempra Energy Solutions that includes a 6.3 megawatt combined heat and power system and several microturbines. The economics of these types of systems is currently very favorable in southern California. Laboratory management has given approval for Sempra to proceed to the detailed audit phase.

J. Off-Grid Generation. NASA completed the following actions in FY 2001 to install new solar hot water, solar electric, solar outdoor lighting, small wind turbines, fuel cells, and other off-grid alternatives: NASA Headquarters sponsored a study to determine the feasibility of a megawatt-scale grid-integrated photovoltaic power system for the Dryden Flight Research Center. The study is being performed by DOE’s Idaho National Engineering and Environmental Laboratory. Results of the study will be available in early FY 2002.

The Space Shuttle organization at Kennedy Space Center used utility rebate funds to modify the controls of a 200 kilowatt emergency generator to enable the Industrial Area to participate in Florida Power and Light’s Commercial/Industrial Load Control program. This program allows the Center to receive a lower utility rate for part of its electrical load in return for agreeing to bring the generator on-line during infrequent load emergency events.

- In FY 2001, Ames Research Center began operating a small windmill to power a remote storm water pumping station. The windmill was installed under the Center’s ESPC contract. The windmill cost \$18,000, will save \$2,000 annually, and will serve as a symbol of energy efficiency and “green” power for this aeronautical research center.

K. Electrical Load Reduction Measures. NASA completed the following actions in FY 2001 to reduce peak demand for electricity, particularly in areas experiencing short-term electricity shortages:

- NASA Headquarters issued a letter on February 6, 2001 providing guidance on emergency energy-reduction measures to all NASA Centers and Component Facilities.
- NASA participated in the Secretary of Energy’s meeting on May 4, 2001, in San Francisco to develop a coordinated response to the President’s directive on energy conservation at Federal facilities.

- NASA Centers and Component Facilities in California implemented voluntary measures to reduce electrical load including use of emergency generators, reduced interior and exterior lighting levels, reduced operating hours for building heating, ventilating, and air-conditioning systems, and adjusted indoor space temperatures. They also established emergency notification procedures to alert employees and contractors to conserve energy when Stage 3 emergencies are anticipated.
- Ames Research Center reduced electrical consumption an average of 12 percent through education, adjustment of equipment run schedules, re-lamping, and duty cycling of equipment. The Center also suspended wind tunnel operations during peak energy usage times and coordinates all wind tunnel tests with the Western Area Power Administration during Stage 1, Stage 2, and Stage 3 emergency events.
- Jet Propulsion Laboratory participated in the California Energy Commission's energy emergency exercise test of its automated Emergency Response Communications System on May 24, 2001. The Laboratory reduced overall energy consumption by over four percent from the previous year and reduced maximum demand by an average of 2.8 percent from June through September 2001.
- The Goldstone Deep Space Communications Complex operated emergency generators up to three hours per day to help relieve load on the California power grid. The DOE ALERT audit at Goldstone investigated the feasibility of extending generator operating hours to sell power back to the grid.
- Johnson Space Center established a load reduction program that can shed up to 1,800 KVA in times of high electrical demand.
- Langley Research Center has a contingency plan in place for the orderly reduction of electrical load during a system emergency.

L. Water Conservation. NASA completed the following actions in FY 2001 to improve water efficiency:

- A comprehensive new NASA directive entitled "NPG 8570.1, Energy Efficiency and Water Conservation Technologies and Practices" was issued on March 15, 2001. This directive provides Agencywide procedures and guidelines for meeting the requirements and goals of EO 13123, using alternative financing, and evaluating renewable energy and water conservation opportunities. Procedures for developing individual Center Energy and Water 5-Year Plans and implementing Best Management Practices for water conservation are contained in the directive.
- Goddard Space Flight Center installed two 500-foot potable water wells through a UESC contract. The wells will supply 7,000,000 gallons of make-up water to the Center's cooling towers. The \$854,000 project will reduce demand on the local water utility's potable water supply and has a payback period of less than three years.