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NASA Green Initiatives

March 2009

While NASA undertakes its mission of exploring the planets, the agency also tends to another important mission - protecting Planet Earth. In recent years, an agency-wide focus on so-called "Green Initiatives" has resulted in each NASA Center and test facility examining and implementing ways to produce and use renewable energy, conserve energy and water, and utilize environmentally friendly materials. This information sheet highlights success stories regarding "Green Initiatives" at a few NASA locations and notes the individuals who have led these efforts.

Partnering for a Solar Future at the John F. Kennedy Space Center

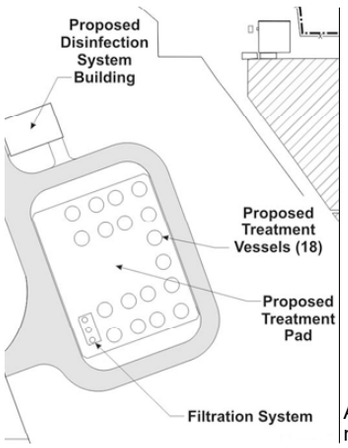
The center of this graphic shows an artist's rendering of the FPL Space Coast solar facility, to be built on KSC land.

NASA's efforts to generate and use renewable energy sources include the ability to form and collaborate on effective public-private sector partnerships. Such is the case at the John F. Kennedy Space Center (KSC) where NASA and Florida Power & Light (FPL) have teamed up to provide both America's space program and Florida residents with new sources of "green power." In June 2008, NASA and the state's largest electric utility signed an agreement that will see FPL build a 900-kilowatt photovoltaic solar power facility at Kennedy to support the electrical needs of the center. It will also help NASA meet its goals for use of power generated from renewable energy.

The KSC-only system is expected to generate about 1.7 million kilowatt hours of electricity per year. This translates to a reduction of almost 1,300 tons of carbon dioxide, nearly four tons of sulfur dioxide and two tons of nitrogen oxide during the life of the project. This total is equivalent to taking 222 cars off the road per year or saving 2,827 barrels of oil - or 137,973 gallons of gasoline, according to the U.S. Environmental Protection Agency (EPA). Photovoltaic systems convert sunlight directly to electricity while consuming no fuel or water or generating any waste. The KSC facility will provide an opportunity for NASA engineers and technicians to gain experience in energy production. It also may serve as a test bed for solar power technology that could be used on the surface of the moon and other planetary bodies. Groundbreaking is anticipated in June-July 2009 and NASA anticipates construction completion by November 2009.

The agreement with FPL will also permit the utility to lease 60 of KSC's approximately 140,000 acres for a 10-megawatt solar photovoltaic power generation system. The agreement is part of a new initiative to cut reliance on fossil fuels and improve the environment by reducing greenhouse gas emissions. The larger solar plant at KSC will be known as the Space Coast facility, which will produce nearly 2 billion kilowatt hours annually - enough energy to serve roughly 3,000 homes. This facility will be built and maintained by FPL, with groundbreaking anticipated by June-July 2009 and taking approximately 12-14 months to complete. The company estimates the plant will prevent more than 227,000 tons of greenhouse gas emissions from entering the atmosphere during the life of the project, which is estimated at 20-40 years. According to the EPA, this is the equivalent of eliminating the emissions from an estimated 2,400 cars annually.

KSC has also partnered with FPL on other projects. These include Utility Energy Services Contract (UESC) projects. The latter are implemented by FPL to save KSC more than $2.6M in energy costs per year. The UESC mechanism allows Federal agencies to enter into agreements with their local utility companies to implement energy conservation projects. Projects are financed by the utility and are paid off from the savings generated, making them budget neutral for the government. These and other cooperative efforts further demonstrate NASA's commitment to using clean energy to benefit both the space program and the nation. ▲



A drawing of the new treatment facility, near the Windsor Reservoir in Pasadena.

Off-site Remediation Project-Pasadena, CA

ADJACENT TO THE JET PROPULSION LABORATORY

Green initiatives conserve water and energy and use environmentally friendly materials. They also include new projects that make a commitment to "green principles." These begin in the design phase and continue throughout the life of a construction project in the form of financial commitments to conservation and innovation. NASA is institutionalizing new contract terms and clauses to conserve water and energy, and use environmentally friendly materials, on a NASA-funded, off-site groundwater cleanup. The project is taking place in Pasadena, CA, adjacent to the Jet Propulsion Laboratory (JPL). The need for the cleanup resulted from waste disposal practices at JPL many decades ago, which resulted in the closing of some neighboring municipal supply wells.

As part of the project, NASA is funding a groundwater treatment facility on land owned by the City of Pasadena, next to their Windsor Reservoir. The facility will treat water from four targeted City of Pasadena

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TEERM
Identifying Environmental Risks & Opportunities

The term - NASA's Technology Evaluation for Environmental Risk Mitigation (TEERM) - may be a long one, but then TEERM covers a lot of ground. As a NASA Principal Center for environmental assurance, TEERM works with domestic and international partners to identify and analyze environmentally friendly materials and processes. Located at the Kennedy Space Center (KSC) TEERM's internal and external customers include NASA's Space Shuttle and Constellation programs, the Department of Defense, private companies and the European Space Agency. In joint projects, TEERM also manages joint testing, prepares reports and disseminates test results.

A TEERM team member applies a thermal spray coating on a Launch Structure at KSC, to test the effectiveness of coatings low in volatile organic compounds.

TEERM has evaluated dozens of technologies and materials ranging from products sent into space, to solvent-free parts washers used at all NASA Centers. Similarly, TEERM is working on more environmentally-friendly paints needed to protect the structural steel of KSC launch pads against corrosion. All materials used on the launch pad must pass 18 months of beach corrosion testing. Safe paints are especially important, as the area is close to a Florida nature refuge. TEERM-tested materials deemed environmentally friendly are placed on what is termed a Qualifying Products list for future NASA and aerospace industry use. The group is also heavily involved with DOD contractors such as Raytheon and Lockheed Martin in researching lead-free alloys used in electronic applications.

Internally, TEERM partners with NASA's Principal Center for Regulatory Risk Analysis and Communication (RRAC), located at the Marshall Space Center. RRAC monitors potential environmental regulatory risks and provides input to the U.S. Environmental Protection Agency (EPA) for development of regulations affecting the aerospace industry. Typically, RRAC identifies risks and notifies TEERM, which is led by Program Manager Chuck Griffin. TEERM then develops well defined testing and analysis programs. The group also works to validate products and processes on products tested for commercial but not aerospace use.

TEERM's research always involves two or more customers, whether they are fellow NASA groups, other government agencies - often the Department of Defense (DOD) - or private industry. Such partnering helps NASA's ability to adopt new materials to reduce unacceptable mission risks in a more proactive and cost effective manner. This was especially true of a collaboration with the U.S. Air Force and Navy to find a primer for aircraft coatings that contained no hexavalent chromium. Boeing, the contractor for the Space Shuttle Orbiter, was also interested in a coating free of the contaminant.

Through TEERM, NASA was able to use the research derived from work with the Air Force and Navy to save on additional testing costs for the Space Shuttle primer. The TEERM team hopes that coatings research conducted on the Space Shuttle will be applicable for materials that may be used on the Constellation Program's Orion Crew Exploration Vehicle and the Ares rocket, scheduled for launch in 2015.

TEERM's success in collaborating with a range of customers has resulted in NASA's ability to better utilize other "green" products - financial resources. By identifying common needs and testing partners, TEERM typically leverages three dollars in other parties' resources for every NASA dollar. Through its work in identifying environmental and regulatory risks, and partnering with a variety of public and private sector entities, TEERM will continue to help NASA practice preventive environmental medicine and identify opportunities for the future. ▲

Kennedy Space Center, Surface Vehicle Fleet
CAPE CANAVERAL, FL

The John F. Kennedy Space Center (KSC) in Florida has launched thousands of vehicles into space, but its vehicle fleets on the ground are also noteworthy. KSC has been a leader in using alternative fuels and vehicles. Since 2005, KSC's fleet of more than 800 alternative fuel vehicles has reduced petroleum usage by the equivalent of 904,029 gallons, meeting and surpassing federal guidelines for increased use of alternate fuels. These practices are consistent with federal Executive Order 13423, including: improving energy efficiency and reduction of greenhouse gases, ensuring that new renewable energy sources are used whenever possible, reducing water and energy consumption and using environmentally friendly and recyclable materials. At KSC, the Executive Order meant a 10% reduction in petroleum consumption (from 1999 levels) by 2005.

The use of E-85 (the pump at right) and Compressed Natural Gas (the tank above) have saved on the use of thousands of gallons of gasoline at KSC.

KSC's effort is led by AFV (Alternative Fuel Vehicle) Program Administrator Bruce Chesson, of the Transportation and Propellant Group. KSC has greatly increased the use of alternative fuels, reduced petroleum usage, and increased public awareness - both at the Center and in Florida. The greatest strides have been in using Ethanol E-85, a mix of 85% ethanol and 15% gasoline. Since 2005, the 651 light-duty vehicles operating at KSC (cars, min-vans etc. weighing less than 8,500 pounds) have increased their use of corn-based ethanol from 144 gallons per month to over 17,300 in October 2008. More than 80% of the vehicles are termed "flex-fuel," operating on both ethanol and gasoline.

KSC has two ethanol stations, augmenting a compressed natural gas (CNG) station installed in 1994. Currently the Center also utilizes 77 light-duty CNG vehicles with another 107 running on B-20, which mixes 80% diesel and 20% bio-mass (mostly soy). When alternative fuel vehicles first arrived at KSC, there was little to distinguish them from their counterparts other than the small sticker inside the gas door that said E-85. To address this challenge, an identity campaign was initiated. It included visiting the on-site filling stations and letting KSC drivers know more about the alternate fuel vehicles. KSC car key tags were changed to include the instruction to fill up with E-85.

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John H. Glenn Research Center

CLEVELAND, OH

Astronauts have remarked how green the earth looks from space. NASA Glenn Research Center (GRC) is a leader in alternative energy research, working on the development of renewable energy sources to make the earth "greener." In fact, GRC efforts - at both Lewis Field and Plum Brook Station - go back more than three decades.

In the mid-1970s, GRC took the lead in the experimental development of wind power. The first wind turbine connected to an electrical grid began operating at Plum Brook Station (PBS) in 1975. In 1977, the Mod-O wind turbine became the first multi-megawatt turbine capable of providing electric power to thousands of homes. Today, GRC conducts research into a wide variety of green technologies. Glenn is heavily involved in developing photovoltaic technology - harnessing the sun's energy and tying it to a power grid. It is also a center for research on regenerative fuel cell system technology, storing the sun's energy for use during the night and to power future space exploration, especially lunar landing and ascent operations. The GRC commitment goes beyond research. The Center's Master Plan, released in August 2007, calls for the use of solar energy and heat pump technology in five buildings at GRC. This will benefit the environment in two ways, by reducing both energy use and emissions.

NASA's energy research has other potential earthly applications, with GRC planning to work with the Great Lakes Science Center on a hydrogen fueling station for fuel cell buses. The proposed station would generate hydrogen by splitting water, using an electrolyzer powered by wind turbines and solar arrays - potentially powering Cleveland's surface public transportation. Other research is being conducted at GRC's former Heated Tube Facility, on alternative fuels, taking existing sources such as coal, methane gas, biomass and shale oil and turning them into a cleaner, more economical alternative to expensive commercial jet fuel.

A conceptualization of a Hybrid bus and hydrogen fuel station for Cleveland public transportation.

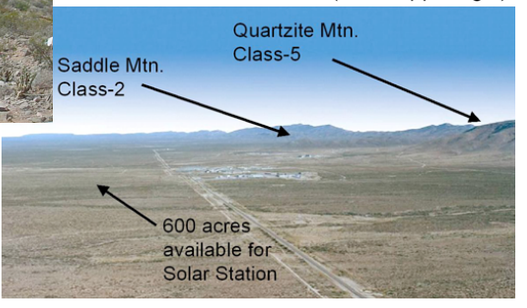
In December 2007, Dr. Valerie Lyons, Chief of GRC's Power and Space Propulsion Division, gave a presentation on the Center's past, present and future energy research before a large NASA gathering (and representatives from the environmental and energy industries and academia) at the NASA Green Forum, held at the Ames Research Center in California. The presentation was repeated for GRC employees on March 4, 2008 and was a staple of Glenn's own Green Energy Forum, held on April 22, 2008 (Earth Day). For decades GRC has collaborated with federal agencies such as the Environmental Protection Agency (EPA), Department of Energy (DOE) and the former Energy Research and Development Agency. GRC anticipates similar collaborative efforts with other NASA centers, resulting in shared energy technologies for space and non-space applications. ▲

Lyndon B. Johnson Space Center

WHITE SANDS TEST FACILITY

WSTF workers conducted wind power testing on Quartzite Mountain (left). WSTF officials later decided to lease out 400 acres of land on site for a solar plant.

This photo below shows the site of the planned solar facility (at left of photo) and Quartzite Mountain (to the upper right).



White Sands Test Facility (WSTF) in New Mexico is a component facility of Houston's Johnson Space Center, testing a variety of propulsion systems for NASA, other federal government entities, and industry. WSTF also performs tests on fluids, flight hardware materials and systems for use with oxygen and the hypergolic propellants. For several years, WSTF has been searching for more efficient ways to provide electricity for these programs and for an on-site groundwater remediation system. In June 2006, the need for increased power was clearly shown on a day when the combined electrical peak load at WSTF equaled the capacity of the El Paso Electric Company (EPEC) substation that services the facility.

NASA has researched alternative energy sources at WSTF for more than a decade. Because EPEC uses natural gas for producing electricity, and natural gas costs were rising substantially, WSTF was determined to seek both price stability and generation of its own power. WSTF studied the practice of "peak shaving," to reduce demand in the middle of the day. Because "demand charge" can amount to half of all electric bills, cutting the peaks and limiting midday demand can substantially reduce these bills.

While peak shaving helped reduce energy costs, NASA saw the need to explore green opportunities. These included researching the possible on-site generation of renewable energy: wind and solar. In 2005, this research intensified, led by Holger Fischer, Chief of the Engineering Office for WSTF Facility Operations. His team looked at harnessing winds from a site at nearby Quartzite Mountain, determining they were at the Class 5 level (Class 7 is strongest) and could potentially support fourteen 1.5-megawatt turbines, enough to power WSTF cleanup operations and supplement commercial power use.

WSTF Environmental staff conducted an Environmental Assessment (EA) of the project in 2007. The EA explored alternatives to the project as well as the potential for any associated impacts, and possible measures to prevent or limit any such impacts. The EA raised concerns that the wind farm, as originally envisioned, could have a negative impact on the area's bat population. Additional studies addressing the concern for bats will be performed in spring 2009. Another challenge to constructing a wind farm would be the need to build an access road to the site, which would cost several million dollars.

NASA turned its attention to solar power, and to possibly developing an on-site plant. NASA sought to make 400 acres of WSTF land available for a private developer to build and operate the facility. To this end, WSTF recently gained authority for Enhanced Use Leasing. This contracting vehicle has enabled NASA to have a company actually come in and build a solar plant. NASA's ultimate goal is to have the successful developer provide enough power for all its WSTF operations. With the El Paso Electric grid in easy reach of the future site of the solar facility, the developer might also be able to sell power to Las Cruces, El Paso and Albuquerque. In May 2008, NASA issued a Request for Information, receiving fourteen responses, and held an Industry Day in August. Within two years, NASA expects to see actual solar production at WSTF.▲

PASADENA CONTINUED FROM PAGE ONE

drinking water wells. NASA is paying for the design, construction and operation of the plant as well as providing technical support to the City of Pasadena, which will be responsible for operating the facility. NASA is executing the cleanup project through a contract with Battelle, which includes an innovative incentive clause. It encourages the use of "green alternatives" in the facility's construction and operation and acquiring goods and services that use sustainable environmental practices. The clause provides a performance bonus of up to one percent of the contract's overall value for employing environmentally friendly alternatives that provide the most impact for the dollar. For example, the use of local, recycled concrete may have a higher purchase cost but may reduce environmental impacts.

These contracting practices are consistent with federal Executive Order 13423. During the early design review, the NASA Cleanup Program Manager and prime contractor sought to make the plant's construction and operation more efficient. This included using the most energy efficient way to get water to and through the treatment facility. NASA examined the way that water has been pumped by the City, which involved pumping water from one of the wells at the top of a hill, having it run downhill to be mixed with water from other wells - and then pumped back uphill. NASA then developed a system redesign so water once at the top of the hill could be pumped directly to the new facility. This will make pumping lower cost, with potential electrical savings of as much as $37,500 per year.

NASA also evaluated a variety of renewable energy options for operating the plant. These included using solar power via photovoltaic cells constructed atop the roof of the existing Windsor Reservoir. Another option involved using what are termed micro-turbines that can be installed within existing water pipelines to generate electricity with an otherwise wasted source of hydropower. Based on NASA's evaluation of these options, the City is considering installation of these renewable energy sources.

Like any federal agency, NASA has to consider both the cost and environmental benefits for implementing sustainable practices. While it sometimes costs more to go green, NASA is demonstrating the benefits to doing so. By incorporating green principles within a thoughtful cost/benefit analysis early in the project planning, the end product can be made better - and more environmentally sound. Groundbreaking for the new treatment facility is scheduled for spring 2009. The completion of construction is anticipated in June of 2010, with treatment plant operations beginning in September 2010. ▲

KSC SURFACE VEHICLES CONTINUED FROM PAGE TWO

While the cars and vans are for KSC use only, they are occasionally taken on business trips serving as test drives. A trip to Georgia proved E-85 competitive with, or better than, gasoline, getting slightly less mileage per gallon but at a much lower price. The success in using E-85 has encouraged State of Florida efforts to produce ethanol through its Farm to Fuel program and increase ethanol pumps on parts of the Florida Turnpike. State transportation officials have visited KSC, learning more about the success of its program. KSC is also expanding the use of low-speed electric vehicles (LSEV), impressively increasing LSEV usage from zero in 2004 to 17 this year. KSC also plans to utilize hydrogen fuel cell vehicles on site - and build a hydrogen refueling station.

In 2008, these efforts earned Chesson and KSC a NASA Blue Marble Award for energy conservation and a Federal Energy and Water Management Award from the DOE. KSC is poised to remain a leader in alternate fuel vehicle programs, as easily available ethanol provides for sustainability and the vehicle fleet operates on all kinds of alternative fuels. ▲

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