Environmental Sustainability Research and Analysis

Michael K. Ewert, Johnson Space Center

The Apollo Program gave humankind a unique glimpse of our planet Earth from a celestial vantage point. People began to think globally about efforts to protect it. Today the world's population is more than six billion. It is increasing by almost 100 million per year. At the turn of the 21st century, human activity affected every part of the planet and every ecosystem. This realization has led to the science of sustainability, and it has led to research aimed at "closing the loop" on our resource consumption.

NASA's mission is "To understand and protect our home planet, to explore the universe and search for life, to inspire the next generation of explorers …as only NASA can." To carry out the new Vision for Exploration, researchers are developing technologies that close the loop for resources and provide renewable energy to support humans away from Earth. Meanwhile, at NASA centers, environmental personnel and facilities engineers strive to reduce the impact of operations on planet Earth.

Through rotational assignments and a memorandum of understanding, the Engineering and Center Operations Directorates have begun a new effort to promote environmental sustainability at Johnson Space Center (JSC).

Air, water, and food resources are threatened and we produce increasing amounts of waste. We must address similar challenges to life support systems on extended-duration spacecraft, but on a much different scale. However, issues such as declining biodiversity, ozone depletion, and climate change show us that the Earth's natural reserves are finite. Our choice of energy sources is expected to be one of the most important decisions that global society will make over the next half century. NASA has much to contribute to these efforts since it is an agency focused on the future.

Sustainability is defined here as development that meets the needs of present generations without compromising the ability of future generations to meet their own needs. To measure progress, we developed a set of sustainability indicators for JSC. We selected and grouped 15 indicators as air pollution, waste/resource use, and energy. Using these metrics, we studied JSC's historical performance.

Technology, when appropriately applied, is one way to improve environmental sustainability, so we studied various technologies that can be used to improve environmental sustainability.

We researched and summarized environmentally beneficial technologies related to air, agriculture/food, energy, fuel cells, sustainable habitats, thermal control, transportation, waste, and water. We can implement at JSC many technologies and practices that save energy or reduce pollution in some other way. For example, we can use combined heat- and power-generation systems to supply electricity and heat energy to JSC facilities simultaneously with less waste. Also, higher-efficiency, non-ozone-depleting refrigerators and freezers could replace some in use at the cafeterias and science buildings. Just as past NASA research and utilization of fuel cells and solar panels

has promoted commercialization of these environmentally important technologies, future research and development can benefit both NASA's space and terrestrial missions.

Systems analysis considers the interactions of complex systems to make wise decisions for the future. Accordingly, we have followed a systems analysis approach in our research to help identify the most promising technologies that will promote sustainability. High-impact areas identified by the analysis were energy efficiency, increased use of renewable energy sources, and waste reduction.

Examples of technology investments include construction of a prototype fuel-cell-powered cart for JSC grounds keeping in addition to planetary exploration and development of high-efficiency chillers that could be used in JSC buildings or spacecraft. We could create a highly reliable backup power system at the center that uses onsite gas turbines, fuel cells, and renewable energy sources rather than diesel engines.

Other examples of technologies that can be applied at JSC to reduce energy consumption and environmental impact are high-albedo roofs and light-emitting diode lights. Increased use of wind and solar energy for water heating and electricity generation can reduce use of fossil fuels that produce pollution and greenhouse gases.

Yet while environmental sustainability activities are already under way at JSC, we can do more. The Sustainability Partnership Working Group formed in 2004 will allow various directorates to coordinate efforts and draw on the talents of their organizations to work toward a common goal—a sustainable future for JSC, NASA, and the world!