Renewable Energy at NASA's Johnson Space Center

Abstract

By Lindsay McDowall

This poster reviews various renewable energy initiatives of the NASA Johnson Space Center. It discusses a lessons learned report on renewable energy at the center over the past ten years, and how solar energy will impact space travel. It also analyzes the success and shortcomings of various solar systems onsite.

Renewable Energy at NASA's Johnson Space Center

Lindsay McDowall, Chemical Engineering

West Virginia University Institute of Technology, NASA Johnson Space Center

Lessons Learned Report

Background

NASA's Johnson Space Center has implemented a great number of renewable energy systems. Renewable energy systems are necessary to research and implement if we humans are expected to continue to grow and thrive on this planet. These systems generate energy using renewable sources - water, wind, sun - things that we will not run out of. Johnson Space Center is helping to pave the way by installing and studying various renewable energy systems.

Objectives

The objective of this report will be to examine the completed renewable energy projects at NASA's Johnson Space Center for a time span of ten years, beginning in 2003 and ending in early 2014. This report will analyze the success of each project based on actual vs. projected savings and actual vs. projected efficiency. Additionally, both positive and negative experiences are documented so that lessons may be learned from past experiences.

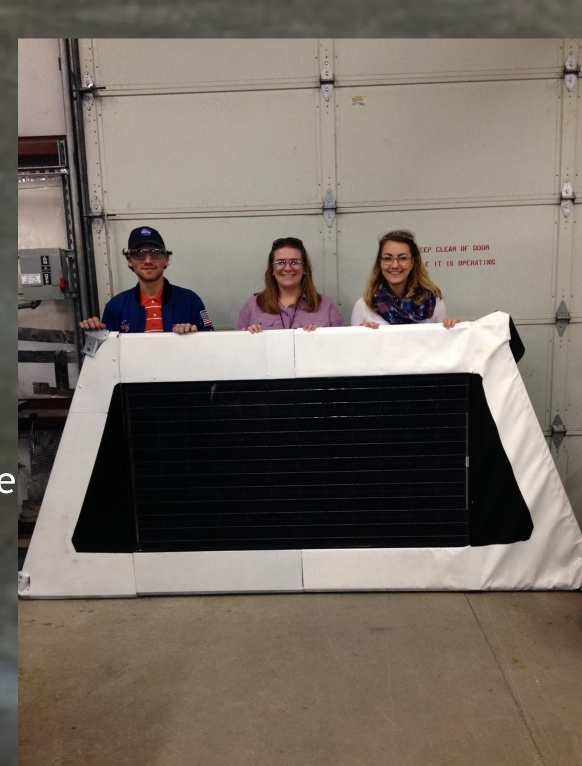
Child Care Center Renewable Energy System

Wind/Solar Hybrid lights previously installed at JSC

E-85 Fueling Station

SPOCC

The Solar Powered Outdoor Collaboration Cupola (SPOCC) is a idea that was conceived in Fall 2012. It is an outdoor collaboration space with charging capabilities. These charging capabilities are made possible through the use of solar power. To the right is a photo of the partial prototype that was completed in March 2014. The completion of the full project will increase knowledge and awareness of renewable energy and will also allow for another creative collaborative space on the JSC campus. The planned location for the SPOCC is between buildings 3 and 4S.



Renewable Energy in Green Buildings

Background

NASA is incorporating renewable energy wherever it can, including into buildings. According to the 2012 JSC Annual Sustainability Report, there are 321,660 square feet of green building space on JSC's campus. The two projects discussed here are major contributors to that statistic. These buildings were designed to meet various Leadership in Energy and Environmental Design (LEED) Certification criteria. LEED Certified buildings use 30 to 50 percent less energy and water compared to non-LEED buildings.

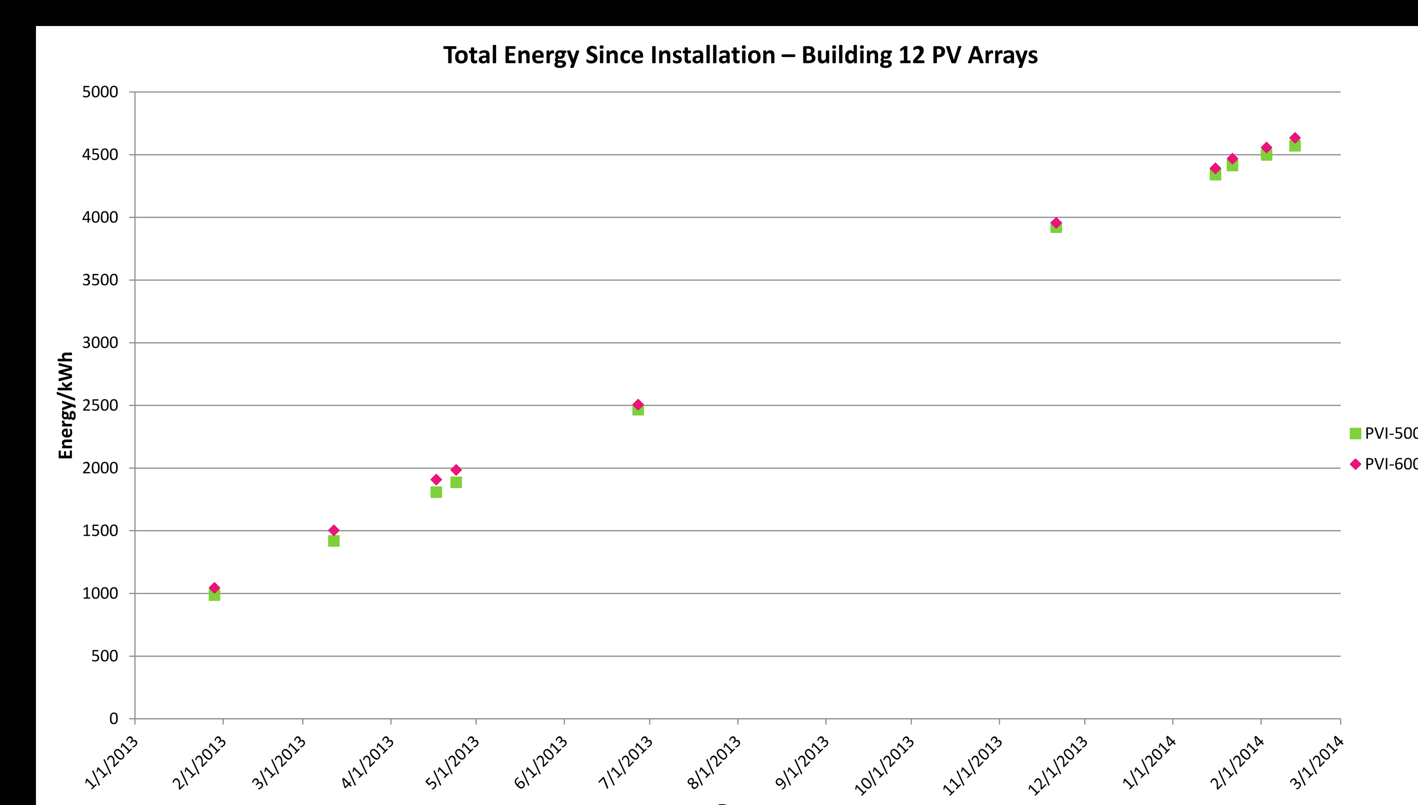
Objectives

The objectives of this project were to examine data from the renewable energy systems in two of the green buildings onsite - Building 12 and Building 20. In Building 12, data was examined from the solar photovoltaic arrays. In Building 20, data was examined from the solar water heater system. By examining the data from the two buildings, it could be determined if the renewable energy systems are operating efficiently.

Results & Conclusions

In Building 12, the data from the solar photovoltaic arrays shows that the system is continuously collecting energy from the sun, as shown by the graph below. Building 12 has two solar inverters, located on the second floor, that collected the data from the solar photovoltaic arrays. The data displayed here is the total energy produced by the system. These are cumulative amounts, so the last point on the graph shows all of the energy collected from the system since the start of its operation.

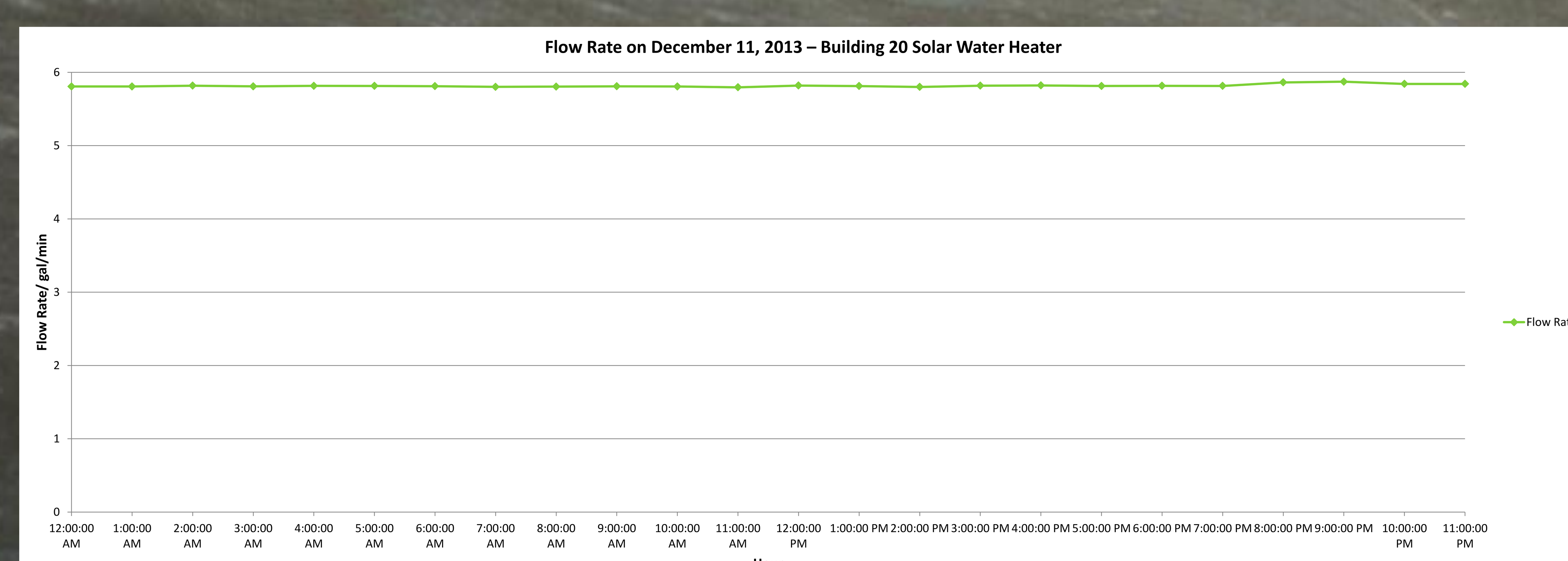
The data shown here was manually collected from the solar inverters. However, the data is also automatically recorded through EBI. Through analysis of both sets of data it was determined that the EBI data was faulty. For example, from the manually collected data it can be determined that a total of 73 kWh of energy was collected between the dates of 1/16/2014 - 1/22/2014. The EBI data reports that approximately 17800 kWh of energy was collected during the same time frame. Not only does this exceed the time frame examined, but it also exceeds the total energy collected from the start of collection as recorded from the inverters. This leads to the belief that there is a malfunction with the automatic recording of the energy.



In Building 20, data was examined from the solar water heater dating back many months and found that the pump for the solar water heater system was not operating properly, as exhibited in the graph shown below.

The pump operates on a solar energy system, meaning that it collects energy throughout the day from the sun. Because of this, the system would stop operating shortly after the sun set because of a lack of sunlight. At that point, the graph should show a zero flow rate, but as exhibited in the graph below, that is not the case. It is clearly shown that the pump is continuously operating, even during the night.

It was also observed that the majority of the time the pump would not turn on at all, despite good weather conditions. This led to the conclusion that the pump is malfunctioning, and needs to be examined and fixed.



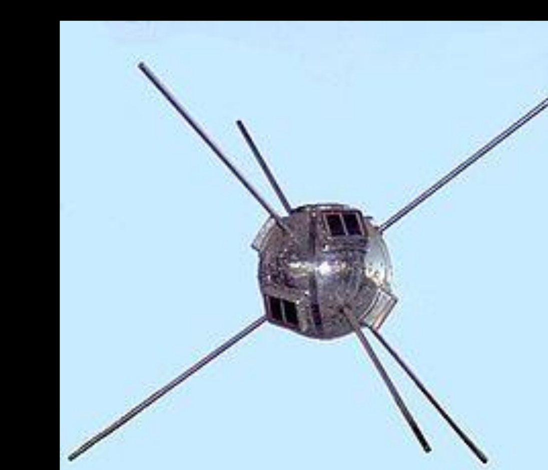
Applications of Solar in Space Travel

Studying sustainability and renewable energy systems on Earth has applications for sustainability in space and vice versa, not only for the International Space Station (ISS) but also for any long term future missions. One of the most well known sustainable technologies with space applications is solar power using solar photovoltaic arrays made with silicon.

Evolution of Solar Power in Space

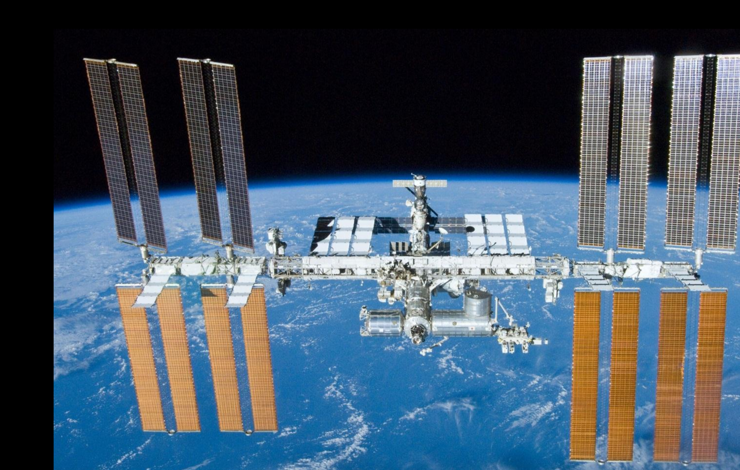
Past

Technician from Bell Labs installing a solar PV array for a first trial. Bell Labs went on to provide solar cells for NASA.



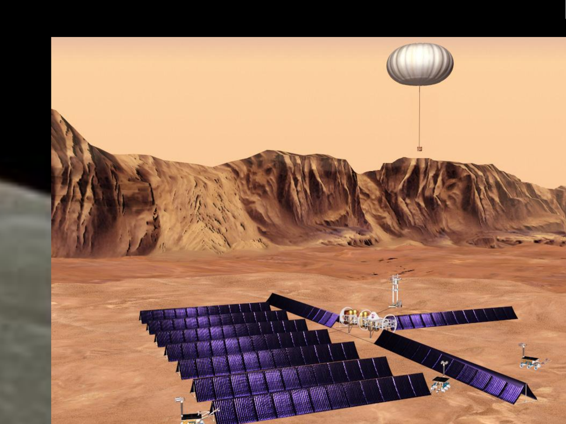
Vanguard I, launched in 1958, was the first spacecraft that used solar panels. The arrays had a 14% terrestrial efficiency.

Present



The International Space Station is powered by over 60,000 silicon solar cells. These cells, at the time of their installation, had an average efficiency of 14.2%.

Future



Artists' renditions of solar power on Mars (top left) and the Moon (top right) for future extended human missions. Currently, the highest efficiency achieved by a silicon solar cell is 42.5%.

References

www.nasa.gov

"Space Cells & Solar Arrays" by S. Bailey NASA GRC, and R. Raffelle RIT

www.alcatel-lucent.com

The Economist Magazine

Acknowledgments

I would like to extend a special thanks to Michael K. Ewert/EC2 for mentoring me; the Sustainability Partnership Team for their help in my research by providing their knowledge; and the Universities Space Research Association for making this experience possible.