Testing a Prototype for Removal of Dust on Photovoltaic Cell

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BACKGROUND

Dust Deposition in most parts of the United States has little impact on solar panel energy production. However, a 2011 Technical Report from NAVFAC found that in the dry desert climate of Camp Lemonnier, Djibouti, losses are much more severe. Shown in figure 1, solar panels can lose 36% efficiency in just one month, 60% efficiency in two months, and after one year have no energy production at all. Due to these high efficiency losses, the Navy determined that to use solar panels in extreme climates, an automated cleaning system must be designed and utilized.

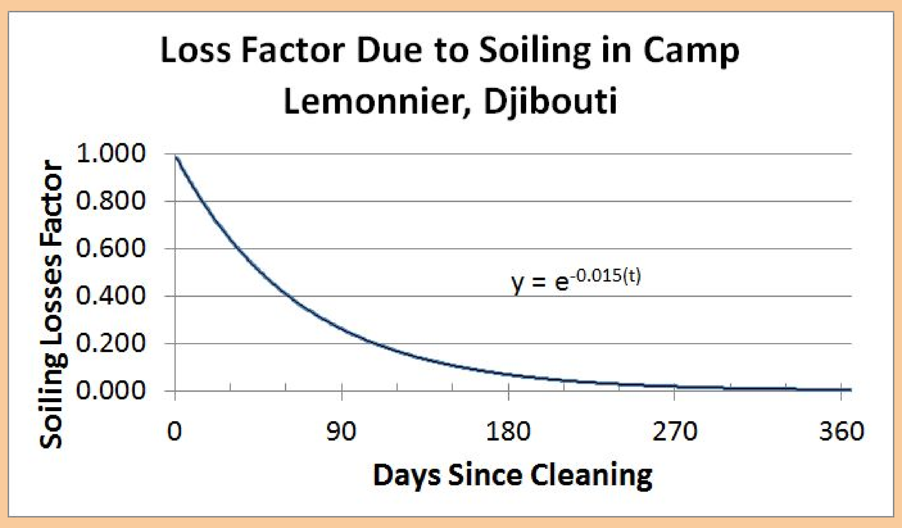

FIGURE 1. Efficiency Losses over time in Djibouti

OBJECTIVES

The prototype was designed to meet objectives important to the Navy. It was designed to run without water, have readily available parts, be easy to install, lightweight, easy to maintain, and run relatively quietly.

PROTOTYPE

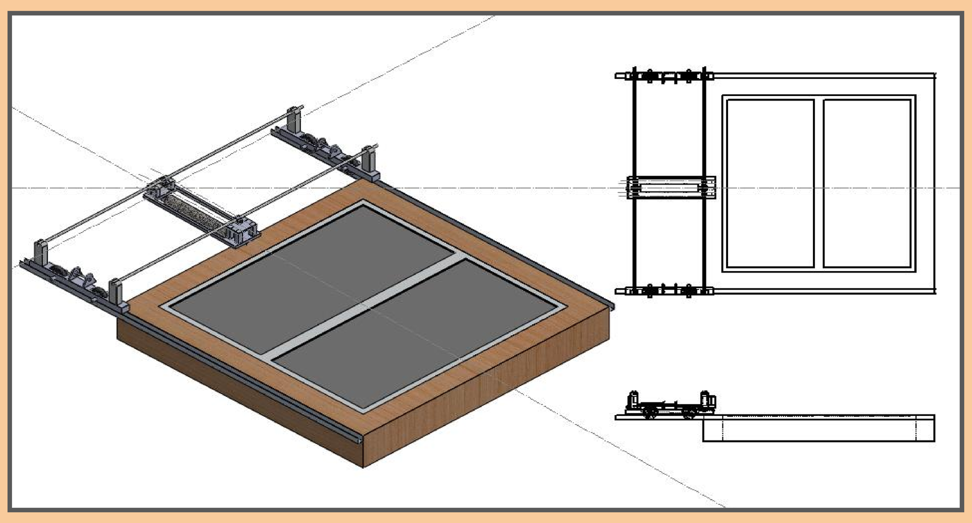

FIGURE 3. Solid Works Drawing of the Prototype

Design

Our prototype uses a polyethylene dry brush system and is mounted on railings that are located on two ends of the solar panels. Wheels move the robot one direction and linear bearings, along with a pulley system, moves the robot another direction. The robot uses an Arduino electronic platform coded specifically for the dimensions of the mock box. This prototype uses materials that were available and easiest to machine. For the next phase, our research will outline what materials would best suit the environment of Djibouti, Africa.

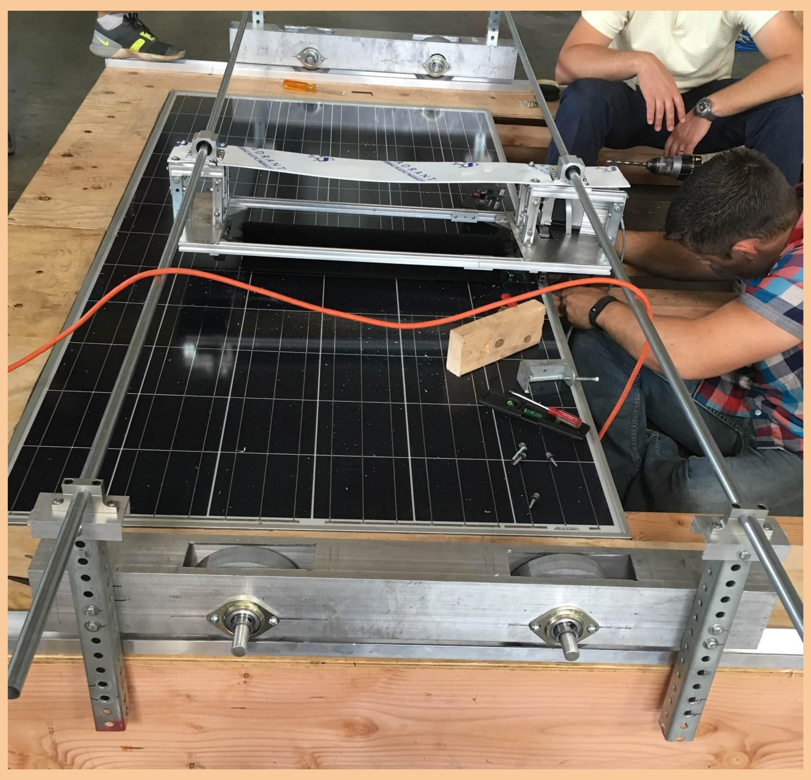

FIGURE 4. Team member working on the automated cleaner

OVERVIEW

Dust deposition on photovoltaic cells severly reduces power output, especially in , and dusty climates. To counter this problem, our team designed an automated, mechanical prototype to clean dust off of solar panels, characterized the effects dust deposition on the photovoltaic cells, and then tested the device in a lab setting

EFFECT OF DUST DEPOSITION

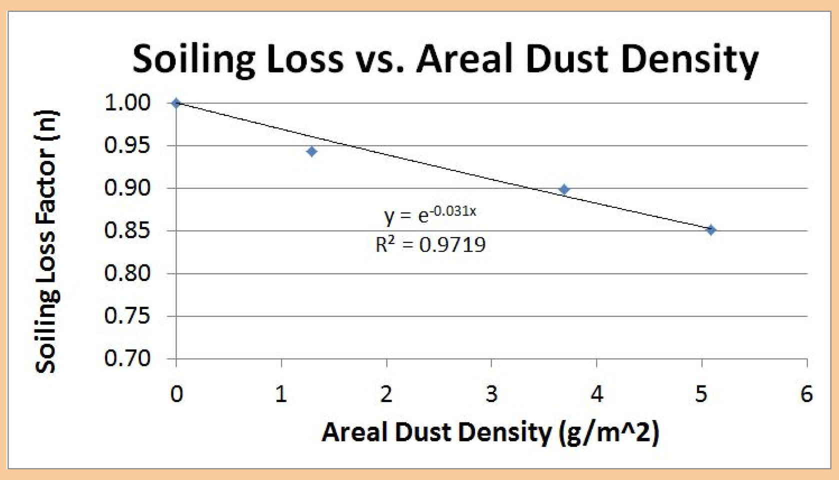

FIGURE 2. Losses due to dust deposition

Solar efficiciencies were compared at known concentrations of dust on the panel. By comparing these losses to the losses expected in the field, we were able to determine the rate of dust build-up on solar panels, and the amount of dust required for testing of the prototype.

RESULTS

CLEAN panel production:	4374.50 kWhr / year	$1,969 USD
Soiled Panel Production First Year:	795.71 kWhr / year	$358 USD
Savings when Panels are Cleaned:	3578.78 kWhr / year	$1,610 USD
Cost of Prototype (Materials Only):	$3,528	
Return On Investment:	1.97 years	

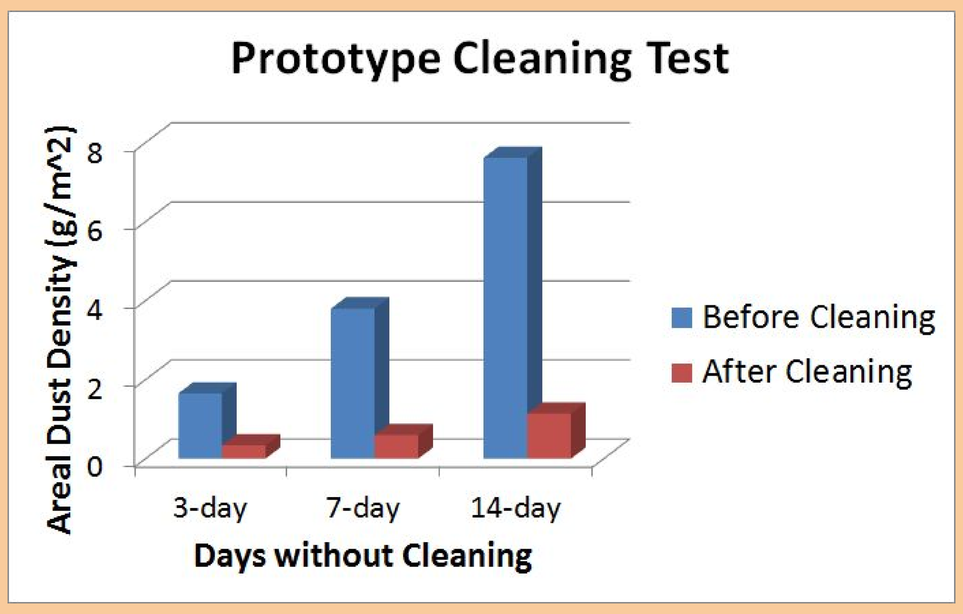

FIGURE 5. Before and after cleaning dust densities for before areal densities that correlate to 3, 7, and 14 days of natural deposition

Our cleaning device would clean sets of 10 panels on the top of living structures. Given the clean and dirty solar efficiencies of these panels, the ROI for our prototype is 1.97 years.

CONCLUSION

The device has an ROI of less than 2 years and succesfully demonstrated that a dry brush system can effectively remove dust from solar panels. The next phase is to develop a cheaper model, and test this model in the field at Camp Lemmonier, Djibouti.