Thesis Project Portfolio

Autonomous Solar Panel Cleaner

(Technical Report)

The State of Solar Panel Recycling: Processes and Legislation

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

As the world searches for energy sources to replace fossil fuels, solar energy is an exciting prospect for green energy production. The number of solar panels in use has increased exponentially over the last three decades, which is great for reducing carbon emissions, but other aspects of the solar panel life-cycle are often ignored. Both of my projects deal with solar panel technology in some way. For my technical project, my capstone group worked to design and build a working prototype for an autonomous solar panel cleaning system that operates without the need for water. My STS research focused on solar panel recycling and global regulations surrounding solar panel disposal. I chose this topic to research because solar panel waste is a little-known problem among even those who own solar panels and very little regulation exists.

Cleaning solar panels is an important part of their routine maintenance. As dust and other debris accumulate on the surface of the panel, they block sunlight which would otherwise be used to produce energy. This cleaning is often inconvenient and even potentially dangerous since many solar panels are mounted on top of buildings; an autonomous cleaning system would eliminate any difficulty and danger from the process. My capstone group, Panel Polishers, based our autonomous solar cleaner on research from MIT. The idea being that a metal plate, charged to a very high voltage, will attract dust off of the surface of a solar panel as it passes above that surface. This is an important advancement because the process does not require water, unlike conventional cleaning methods. Many large solar farms are located in dry, hot areas with lots of dust where it can be very expensive to pump the large quantities of water needed for cleaning. This technology also enables solar panels to be cleaned while touching the panels' surfaces as little as possible; traditional methods of scrubbing can scratch the glass surface, reducing a solar panel's efficiency. Our design consists of a brush to remove any large debris, followed by the

charged metal plate to attract all of the fine dust particles. These two systems are powered by DC motors on two separate leadscrews so that they may run independently. This system could increase the efficiency of solar panels by ensuring that they are free of light-blocking debris and keeping the surface free from scratches.

Even though solar panels are considered a clean energy source, they have the potential to create massive amounts of waste as their 25-year life expectancy runs out. My STS research asks the question: "*Why is solar panel recycling ignored by manufacturers and governments?"* To answer this question, I read journal articles about solar panel composition and recycling techniques as well as reading legislation for several of the countries with the largest solar industry including the European Union, India, China, and the United States. Finally, I also researched the few American manufacturers that offer solar recycling services. Through this research, I learned that solar panel recycling is important for several reasons besides the space that millions of tons of solar waste take up. Solar panels contain toxic chemicals like lead and cadmium, which may leak from landfills and contaminate ecosystems. Rare and valuable materials like silver are also found in solar panels; each solar panel that ends up in a landfill takes that silver out of the global supply. One reason why solar panels are not recycled today is because of how integrated all of its parts are; it becomes very difficult to separate panels into its constituents. My research finds that the struggle to make complicated processes for breaking down solar panels profitable is the biggest hurdle for the more widespread adoption of the practice. Some success has been seen in the European Union with their adoption of mandated recycling, but more research needs to be invested in improving recycling processes.

My STS research into solar panels coupled with my technical project helped me to better understand the full scope of this important technology and the work that will be necessary to

keep solar energy sustainable. I would like to thank my advisors, Michael Momot and Joshua Earle, as well as my capstone teammates, Joshua Belisle and Brandon Bonner, as without them, I would not have been able to complete these projects.