Engineered Phototropism: Improving the Energy Efficiency of Residential-Use Solar Tracking Using Soft-Bodied Thermal Expansion

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Centralized power grids in developed areas are currently the main benefactor of renewable energy advancements and are predicted to be completely renewable by 2032. However, with methods of energy generation and distribution varying globally, decentralized power grids in underdeveloped areas are lagging behind in the global push toward renewable energy. This project aimed to adapt solar tracking—the technique of significantly increasing solar energy production by orienting panels to directly face the sun—to the smaller-scale applications found in decentralized power grids by eliminating the energy cost of traditional solar tracking mechanisms. Inspired by phototropic plant life, the passive solar tracking mechanism actuates by a variance in air pressure within air pockets in a soft body, mimicking the expansion and contraction of cells within a plant stem. A thermally-responsive actuation was engineered by embedding tin strands in each air pocket. Externally heating the embedded tin strand causes a passive increase in air pressure within each air pocket. Respective air pockets are expanded by the resulting surface thermal gradient of exposed tin strands caused by the offset angle of the sun directly heating only select sections of the metal surface. The power output across an 8-hour testing period was gathered for both the passive solar tracker and a static panel at its optimal orientation. The passive solar tracking assembly was demonstrated to significantly increase power output ($p < 0.00001$), specifically in the early morning and late afternoon hours. Introducing passive solar tracking designs to the solar energy industry can facilitate renewable energy integration in underdeveloped areas, largely contributing to push toward global renewable energy usage.

Awards Won:

Fourth Award of $500

University of Texas at Dallas: Scholarship of $5,000 per year, renewable for up to four years