Solar Updraft Tower-Wind Turbine Hybrid: Optimizing Power Generation in Multifarious Climatic Conditions Using Computational Fluid Dynamics Analysis

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BACKGROUND World energy consumption will increase 28% by 2040 with renewables being the fastest growing energy source. Furthermore, renewables will increasingly replace coal. Solar updraft towers can take full advantage of abundant solar energy, however, they are expensive to build, with about half of the total cost being attributed to the solar collector construction. Additionally, solar collectors consume significant amounts of land space (up to 277 hectares). HYPOTHESIS An optimally designed structure that incorporates a solar updraft tower and a wind turbine (solar updraft tower wind turbine hybrid) could be constructed with a certain design and materials to maximize power output over wide-ranging meteorological conditions and at a significantly lower construction cost. METHODS and PROCEDURES The design principles were based on research from subject matter expert resources. Original concept designs were created with hand sketches. Several virtual 3D prototype models were analyzed using computational fluid dynamics analysis software. During the prototype build, some modifications were made to accommodate for limitations with fabrication capabilities. Once the prototype model was complete, a series of tests involving high solar exposure and varying wind conditions were tested. Data was captured and analyzed for statistical significant improvements. DATA ANALYSIS and CONCLUSION The solar updraft tower wind turbine hybrid performed statistically higher when combining solar power and lower (<4 mph) wind velocities. There was not a statistically significant boost in power when combining solar power and higher (>4 mph) wind velocities, however the hybrid design still generates over 166% more power than a solar updraft tower alone.

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