Smart Sheet for Wind and Solar Dual-Energy Harvesting in the Dusty, Windy and Sunny Rift Valley Region of Kenya

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Résumé

Conventional photovoltaic (PV) systems rely predominantly on sunlight intensity and are greatly affected by dust accumulation and solar intermittency. These limitations significantly reduce energy conversion efficiency, particularly in regions with frequent dust and variable sunshine, like the Narok region in the Rift Valley, particularly around Maasai Mara University. Moreover, existing PV technologies do not utilise the thermal component of solar radiation or kinetic effects induced by environmental conditions such as wind, which are dominant in Narok. A gap therefore exists for robust, multifunctional energy-harvesting materials that can address both the thermal and mechanical energy potentials present in outdoor environments.
We propose to develop a wind and solar dual-energy harvesting device composed of a piezoelectric thin film integrated onto a mechanically flexible substrate that can exploit mechanical strains generated by two distinct environmental sources: wind-induced motion (fluttering or flapping) and thermal-induced cycling (expansion or contraction) caused by solar infrared radiation. These mechanical strains are transduced into usable electrical energy through the piezoelectric effect. The system will be optimised for resilience in dusty, arid, and thermally dynamic environments, which are prevalent in the Rift Valley of Kenya.

The substrate that will be used is characterised by low thermal conductivity and high thermal expansivity, deforming when heated by solar IR radiation and returning upon cooling, inducing cyclic strain in the piezoelectric layer. Simultaneously, in windy conditions, the substrate is expected to flex or flutter, creating further dynamic strain. Electrodes will be patterned to capture the generated voltage. The device's resilience to environmental degradation will be ensured through encapsulation and the use of non-conductive, hydrophobic surface treatments. The feasibility of these innovative concepts is supported by physics and materials science, underpinning how the said materials respond to environmental stimuli (solar, wind, storms, etc.).

Mots-Clés: Wind, solar, dual energy harvesting, piezoelectric layer, mechanical strain, transduce, electrical energy, Rift valley, Narok

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