Fluttering flags to harvest power looks promising to researchers

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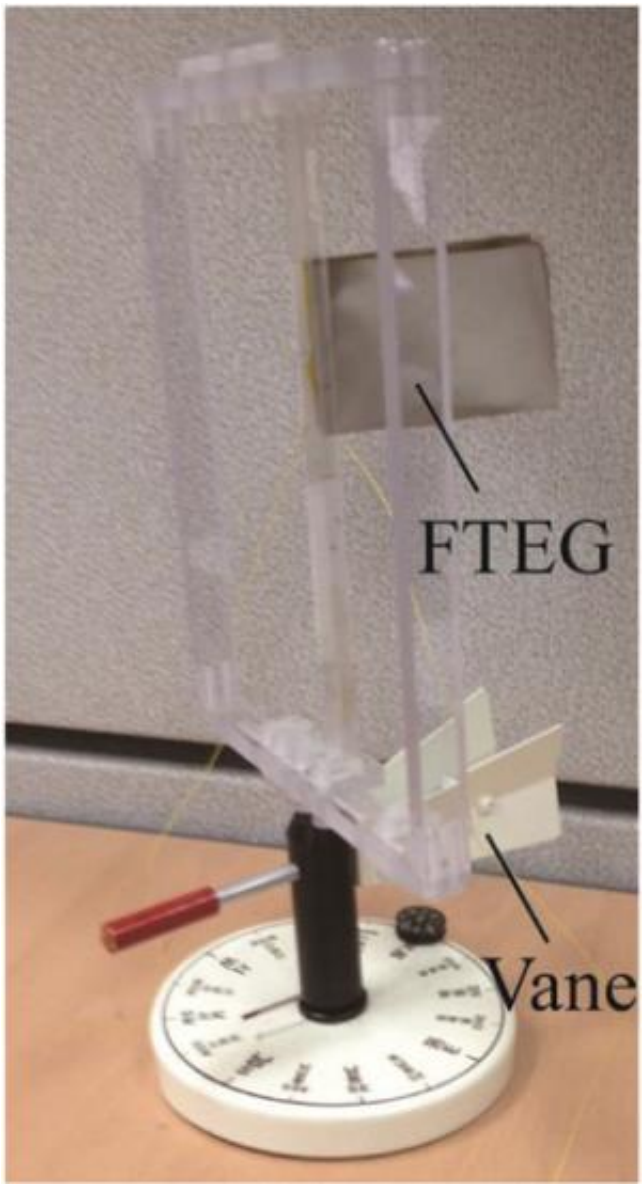

Credit: *Nature Communications* 5, Article number: 4929 doi:10.1038/ncomms5929

"Flutter-driven triboelectrification for harvesting wind energy," published this week in *Nature Communications*, is a study of note for those interested in what researchers are exploring as sources of clean and sustainable energy. The authors have various affiliations with Samsung Institute of Technology (SAIT), Seoul National University, Korea Advanced Institute of Science and Technology (KAIST), Samsung Electronics, Chonnam National University and Georgia Institute of Technology. Their generator uses contact electrification caused by the self-sustained oscillation of flags. The authors said that "flutter-driven triboelectric generation is a promising technology to drive electric devices in the outdoor environments in a sustainable manner." Translation: Power is obtained from the fluttering motion of a flag-like structure. Business Insider Australia's Chris Pash said, "The flutter-driven triboelectric generator is based on the principle of charge transfer when two materials are rubbed together, similar to when a balloon is rubbed against clothing and then sticks to a wall."

Nick Stockton in Wired described the generator as building a charge "using mechanics that are similar to rubbing a balloon on your nephew's head." He explained the process: "when a breeze hits the small contraption, the electrode-coated flag stirs into motion, brushing against a conducting counter plate. This rubbing action builds a static charge on the counter plate's polymer surface, in what's called the triboelectric effect. A small capacitor gathers the charge."

The material used was a synthetic textile coated with gold, a highly efficient conductor, added Stockton. Each counter plate, he said, sandwiched another piece of the gold-coated fabric between a baseboard and polymer called PTFE. "When the gold flag flaps against it, it builds up a nice static charge, which the gold in the baseboard then conducts into the capacitor." Over 12 million flutters later, a test flag began to tatter but showed only a tiny decrease in power output, said Stockton.

What about capturing otherwise wasted mechanical energy from such sources as walking, wind

blowing, vibration, or ocean waves? Zhong Lin Wang of Georgia Tech in December last year gave an interesting presentation in a video on the energy around us. Georgia Tech researchers are developing a family of power generators that take advantage of the triboelectric effect, to produce small amounts of electricity for portable devices and sensors.

Professor Wang in the video said, "We look for new energy but energy is around us, everywhere, all the time." Referring to an illustration of a top and bottom of a shoe-box like structure, he said, "What you see here is A materials and B materials." When they become physically in contact, he said, there is a charge transfer. If they are separated by a gap, there is a voltage generated .In a second mode, if one part is sliding against the other, there is also a charge. One mode is physical contact and the other one, sliding. He said, "This is the two-phase mode we use." The triboelectric effect, is used to create "surprising amounts of electric power by rubbing or touching two different materials together," said a Georgia Tech News Center report. "The fact that an electric charge can be produced through triboelectrification is well known," Wang explained. "What we have introduced is a gap separation technique that produces a voltage drop, which leads to a current flow in the external load, allowing the charge to be used. This generator can convert random mechanical energy from our environment into electric energy."

Each flag creates a small amount of electricity; the authors suggest building arrays of flag generators might be required to generate substantial amounts of power, Stockton said.

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Abstract
Technologies to harvest electrical energy from wind have vast potentials because wind is one of the cleanest and most sustainable energy sources that nature provides. Here we propose a flutter-driven triboelectric generator that uses contact electrification caused by the self-sustained oscillation of flags. We study the coupled interaction between a fluttering flexible flag and a rigid plate. In doing so, we find three distinct contact modes: single, double and chaotic. The flutter-driven triboelectric generator having small dimensions of 7.5 × 5 cm at wind speed of 15 ms?1 exhibits high-electrical performances: an instantaneous output voltage of 200 V and a current of 60 ?A with a high frequency of 158 Hz, giving an average power density of approximately 0.86 mW. The flutter-driven triboelectric generation is a promising technology to drive electric devices in the outdoor environments in a sustainable manner.