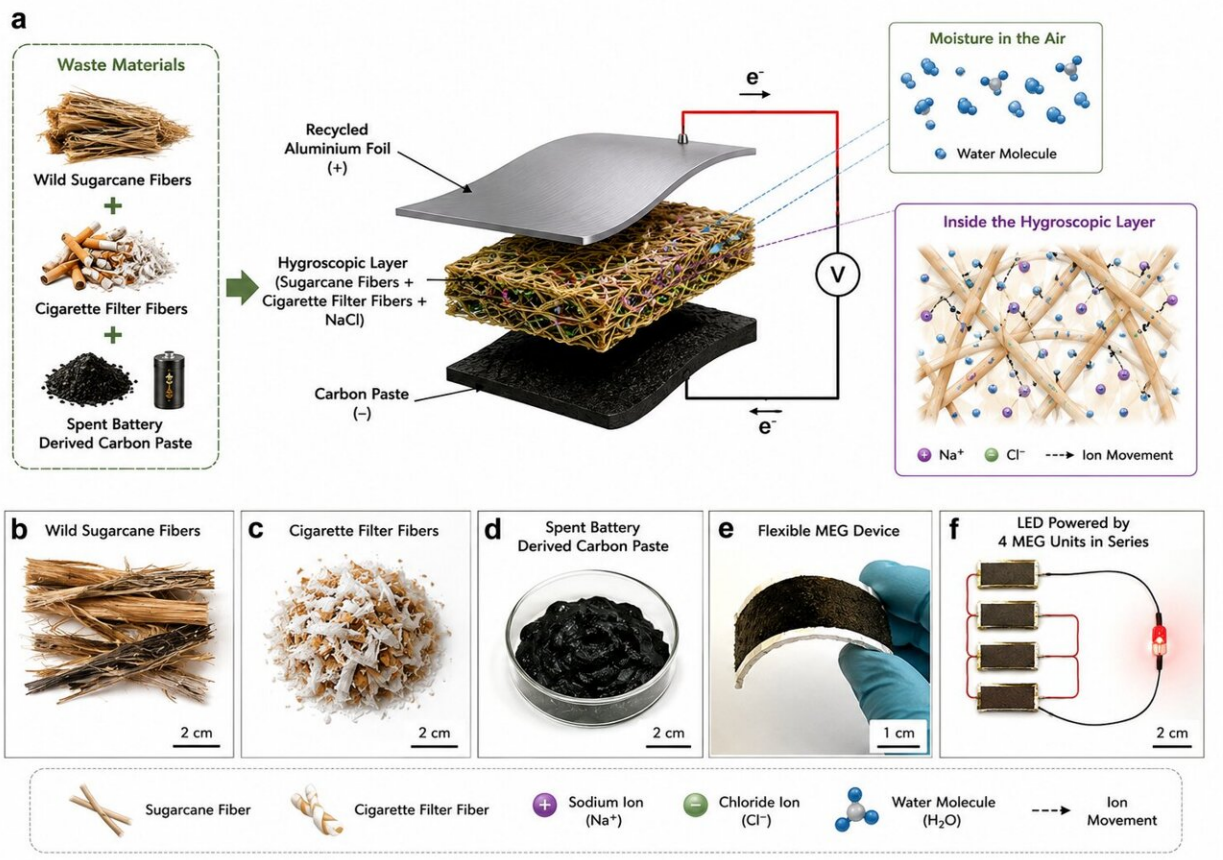
This device pulls electricity from humid air using waste materials

July 16 2026, by Sayan Tribedi



(a) Schematic of the moisture-driven electricity generator (MEG) showing its layered structure and working principle. (b) Wild sugarcane fibers used as the hygroscopic biomass. (c) Recycled cellulose fibers recovered from discarded cigarette filters. (d) Carbon paste prepared from spent dry-cell batteries. (e) Flexible MEG device fabricated from the recycled materials. (f) Four MEG units connected in series to power a red LED under humid conditions. Credit: Adapted from the study Aman Ul Azam Khan et al, Sustainable moisture-driven

electricity generation using waste materials, *Scientific Reports* (2026). DOI: 10.1038/s41598-026-61180-8 and refined by AI

Imagine what would happen if the source of your electricity was not the sun, wind, or water flow, but rather the moisture present in the air? The ability of moisture to provide energy has been well-known for a long time, although harnessing that invisible power for generating electricity has been a difficult task. Until recently, all of the proposed generators were either inefficient or too expensive to use in real-life settings.

As reported in a study in *Scientific Reports*, scientists were able to create a low-cost and flexible electrical generator that harnesses the energy from moisture and also gives a second life to waste materials.

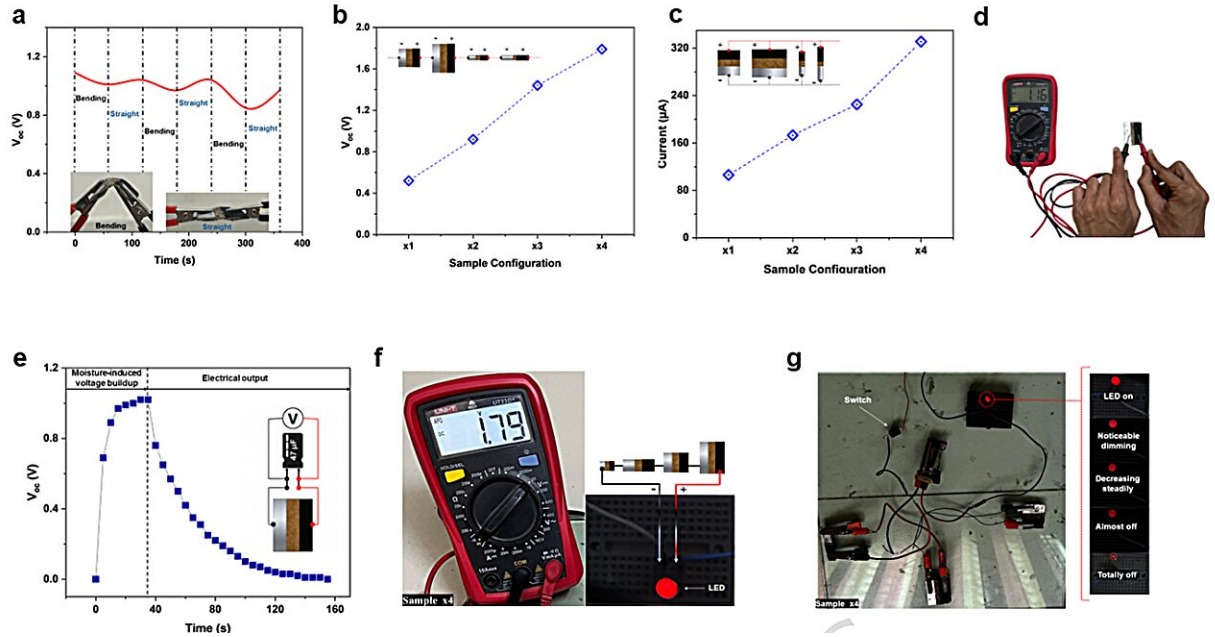
A single generator was capable of producing enough voltage (up to 1.16 volts) to surpass many of the previous humidity-based generators, and multiple generators can even provide the energy needed to light up an LED light bulb without using any external capacitors.

Energy in thin air

The concept of harnessing energy from water vapor is not new, but previous efforts have been unsuccessful. All of the existing water-based power generators are dependent on expensive nano-materials that can generate only a few millivolts. In fact, the authors note that earlier moisture-electric generators "typically produce voltages of ≤0.6 V, which is insufficient for direct integration into wearable electronics."

The new design changes tack: it uses cheap, upcycled ingredients and clever chemistry. Unlike a normal battery, it generates electricity only when humid air creates an ion gradient. As the team explains, the device

acts as a "humidity-driven energy harvester in which electrical output arises from the formation and relaxation of moisture and ionic gradients, rather than from stored chemical energy".



Four moisture-driven electricity generator (MEG) units connected in series powering a red LED under favorable high-humidity laboratory conditions. The demonstration illustrates that linking multiple devices can provide enough voltage to operate a low-power electronic component, although the system relies on maintaining a moisture gradient and does not function as an energy-storage battery. Credit: Aman Ul Azam Khan et al, Sustainable moisture-driven electricity generation using waste materials, *Scientific Reports* (2026). DOI: 10.1038/s41598-026-61180-8

From trash to tiny power

In the prototype, the researchers have stacked together natural plant

fibers and waste materials. They utilized Saccharum cane stalks, which were invasive wild plants, along with filters containing cellulose from discarded cigarette filters in cities. Table salt (NaCl) was applied in layers, while one side had a carbon paste applied, made from batteries. The second layer was covered with aluminum foil as an additional electrode.

The resulting material is a thin, flexible, paper-like layer that absorbs moisture in humid air and becomes conductive, allowing ions to move freely. In experiments, such a layer could generate up to 1.16 V under 65% humidity conditions—nearly twice as high a voltage as all the previous devices. (For comparison, four layers in series could create 1.79 V with 0.323 mA current that could light a small LED for more than three hours continuously.)

Salt and sweat: How it works

The "secret sauce" is really plain salt and water. As moisture permeates the fibers, it dissolves NaCl into Na^+ and Cl^- ions. These charges then drift through the damp mat of fibers toward the electrodes. On one side, they meet the carbon paste, on the other side, the aluminum foil, creating a steady separation of charge and thus a voltage.

In the authors' words, the entire effect comes from the internal gradient of moisture and ions—not from any hidden battery chemistry. (Removing the salt layer essentially kills the voltage.) Moisture-loving materials like cellulose hold water and let it spread; the recycled filter fibers help wick the moisture and carry the salt uniformly.

The team's basic model predicts that at moderate humidity (~65%), ion generation and transport are maximized, giving peak voltage, whereas at very high humidity, the device leaks charge and voltage steadiness falls off.

Tiny LED, big test

Tests carried out in laboratories found the best efficiency when moisture was at moderate levels, as this helped to form the most effective internal ion gradient. The use of four devices in series allowed generating electricity to power a small red light-emitting diode for more than three hours without a capacitor, which proves that the devices can be used in groups to achieve greater efficiency.

However, the authors note that the innovation should not be considered as an alternative to batteries but rather as a way of harvesting energy. It has lower efficiency once the internal moisture gradient disappears, and the energy can only be used by low-power electronic devices. Further research on the durability and real-life weather conditions is needed.

At the same time, the innovation demonstrates an interesting perspective. It is possible to transform trash such as cigarette filters, batteries, and plant fibers into energy harvesters, which would help to generate electricity for small gadgets.

More information: Aman Ul Azam Khan et al, Sustainable moisture-driven electricity generation using waste materials, *Scientific Reports* (2026). DOI: 10.1038/s41598-026-61180-8

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