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# The wood magician and his amazing strip of paper

How a tiny battery made in Switzerland ended up on the list of the world's best inventions.

DÖLF BARBEN

What is it? To be honest, it looks a bit underwhelming. Like something a child has stuck together: a small cut-out figure with a dark coat and two tiny antennas.

Reality tells a different story. What resembles a scrap of paper is in fact a battery that was invented and developed in Switzerland, at the Swiss Federal Laboratories for Materials Science and Technology, Empa – an object so remarkable that it made it on to the 2022 list of the world's best inventions.

Published annually by the US magazine "Time", the Best Inventions list honours "200 innovations changing



Higher, farther, faster, more beautiful? In search of somewhat unconventional Swiss records

**This edition: The new biodegradable paper battery**

how we live", as the jury puts it. The list covers all manner of inventions. These include a smart water sprinkler, a heat-free hairdryer, a powerful smartphone microscope, and the James Webb Space Telescope. And hidden away in the "Experimental" category? The small, inconspicuous and slightly tatty-looking Swiss paper battery.

You can tell how well Empa's invention was received, because the jury chose not to group it together with the technical gadgets – like the streaming headphones that you can wear underwater, or the on-the-go baby bottle warmer. Nor did they list it under the fun stuff like the indoor

garden for beginners or the teddy bear that hugs back.

Like the Covid breathalyser test and the new NASA space rocket, the paper battery was one of the few innovations referred to by the jury as "breakthrough" inventions.

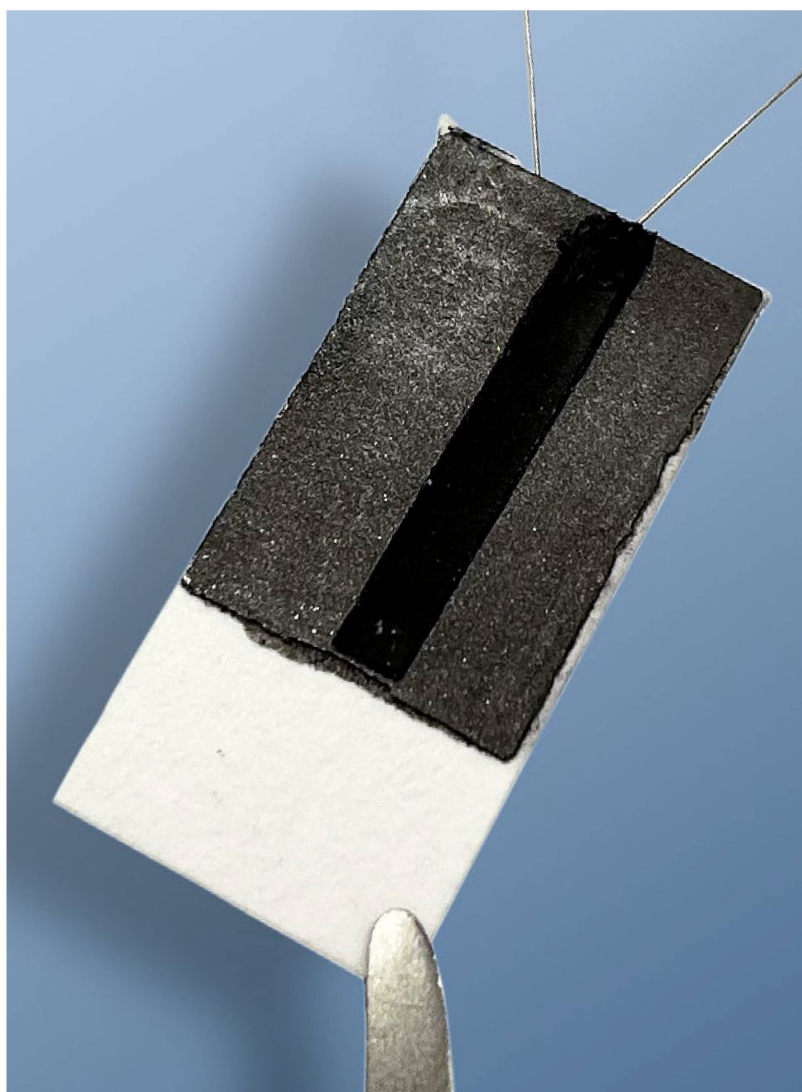
A sliver of paper mentioned in the same breath as a space rocket – remarkable. As the "Time" magazine website says, the paper battery is an invention aimed at reducing e-waste. Not only is the paper biodegradable, but so are the battery's other components. Hence the battery is not just a breakthrough – but an environmental breakthrough.

Gustav Nyström and his team created it. The Swedish-born Nyström has headed the Cellulose & Wood Materials Laboratory at Empa since 2018. Cellulose is the main substance in the wall of plant cells and, like wood, a sustainable biomaterial.

Nyström studied the conductive qualities of natural materials for his PhD. This was how he soon came up with the idea of a biodegradable electricity storage device. He found the ideal work environment at Empa "because renewable and sustainable materials and solutions inform everything we do here", he says. The title of an article dedicated to Nyström on the Empa website refers to him as the "wood magician".

Certainly, Empa is no longer simply the "Building Materials Testing Institute", as it was initially called when it was founded in 1880. In recent decades, the organisation has developed into a multi-branch research hub. It sees its core mission as carrying out solution-oriented research – for industry, but also for society.

Nyström himself is keen to stress the social dimension more than anything else. Although he is a physicist, he talks more like an environmental scientist. He will happily explain how



It looks a bit like a piece of cobbled-together handicraft (held here in a pair of tweezers) but was named one of the world's best inventions in 2022.

Photo: Empa



the paper battery works (see box below), but soon starts emphasising the “bigger picture”, the potential ways in which the battery can be used, and how we can protect the environment. Nyström, 41, has three children. He wants his work, “above all, to contribute to a better future”, he says.

The paper battery is not a particularly powerful battery, nor does it have to be. There are now a wide range of small disposable electronic devices that run on very little power. These can be medical diagnostic devices, for example, or battery-powered smart parcel boxes that enable delivery tracking and even allow the temperature of sensitive items such as vaccines to be monitored during transit.

### Water as the trigger

The Empa battery is made of a small strip of paper on which three different inks are printed. The ink on the front contains graphite flakes and acts as the positive end of the battery, while the ink on the back contains zinc powder and acts as the negative terminal. A third, special ink is printed on both sides of the paper, on top of the other two inks. Salt is dispersed throughout the strip of paper. Ingeniously, you activate the battery with water. One drop is enough. As soon as the paper is wet, the salts within the paper dissolve and the battery charge is released. But if the paper remains dry, the battery retains its charge. There is one disadvantage: the battery will only work for as long as it is wet. Tests show that it can keep a low-power alarm clock running for about one hour before it dries. Although pressure, heat or an external electromagnetic field could conceivably also be used as a battery trigger.

(DB)



Nyström also sees potential in wearables, which are any technology designed to be worn for the purpose of monitoring things like heart rate or blood sugar. Furthermore, paper batteries would be more or less ideal for use in outdoor measuring devices. If for whatever reason the batteries were never retrieved, they would eventually decompose anyway.

Like the latest NASA space rocket, are we also about to see the stratospheric rise of the paper battery? Some companies have already expressed an interest, says Nyström, but whether anything comes of it

Researcher and inventor Gustav Nyström believes in the bigger picture: “protecting the environment”. Photo: Empa

Good for compost: Empa has also developed a capacitor, which disintegrates after two months buried in the soil, leaving only a few carbon particles. The new paper battery decomposes in much the same way. Photo: Gian Vaitl / Empa

remains to be seen, he adds. Yet what we do know is that he and his team will carry on researching. Their paper biodegradable supercapacitor is already at a very advanced stage of development. They also have an idea along the lines of a display system. “We see many exciting possibilities.”

All that remains is to ask the inventor which other inventions on the “Time” magazine list he finds intriguing. Nyström is true to form in his response. He doesn’t mention the “chameleon car” that can change colour, or the AI system that can create images and art. The inventions that Nyström describes as “particularly interesting” relate to sustainability – like the devices and methods that have been pioneered to help remove CO<sub>2</sub> from the atmosphere.

Video: [revue.link/empa](https://revue.link/empa)

