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New cooling mechanism set to revolutionize conventional environmentally harmful refrigeration technologies

**LIST researchers publish promising results in prestigious Science magazine.**

Approximately one-fifth of the world's electric energy is dedicated to refrigeration, and the International Energy Agency anticipates a twofold increase in the number of air conditioning units by 2040. Despite a century of advancements, existing refrigeration systems, relying on vapour compression, have hit their thermodynamic threshold. These systems not only emit greenhouse gases, contributing to environmental issues, but also produce significant noise. Prioritizing the development of energy-efficient and eco-friendly systems is thus paramount to address global warming and encourage the responsible utilization of natural resources.

Now, a team of researchers from the Luxembourg Institute of Science and Technology (LIST) have developed a technology with the potential to transform future refrigeration systems. Their latest research milestone, [published in Science this week](https://www.science.org/doi/10.1126/science.adi5477), details the mechanism, which focuses on using the electrocaloric effect – a phenomenon wherein a material undergoes a reversible temperature alteration when subjected to an electric field – to achieve the desired result.

In this particular case, the electrocaloric effect involves applying an electric field to ceramic capacitors, inducing temperature changes, and creating a cooling effect. “Our proposed solution involves an assembly of multilayer capacitors stacked within an electrically connected fluid-filled pipe,” explains Dr Emmanuel Defay, who leads the Nanotechnology unit within the Materials Research and Technology (MRT) department at LIST. Defay and his team have been working on electrocaloric materials for several years. “The fluid flows back and forth between the capacitors, creating a temperature gradient,” he adds.

A diagram of a multilayer capacitors

Description automatically generated

This assembly, called a regenerator, could eventually replace the conventional compressor and the environmentally harmful fluids in current refrigerators, providing a more energy-efficient and sustainable cooling solution. Indeed, energy efficiency is another key advantage of this technology.

The potential applications of this technology extend beyond refrigeration, including air conditioning “Our research was previously detailed in an article in Science three years ago. We have achieved significant milestones since then, with our latest paper showcasing promising developments, notably regarding energy efficiency and scale-up solutions.”

Defay’s team is currently actively engaging with various companies to explore practical applications of the technology, marking an important step towards the implementation of the solution. Indicatively, the regenerator was designed in collaboration with the Japanese manufacturing company Murata.

“While we are already making tangible progress, we are continually working to enhance the maturity and practicality of our technology. The ultimate goal is to offer a viable and sustainable alternative to current refrigeration solutions,” concludes Defay.

Dr Damien Lenoble, director of the MRT department said, “Addressing energy-related challenges has been set among our research priorities over the past five years. It is imperative to showcase the applicability of our cutting-edge materials in technologies that effectively harness energy, produce and store green hydrogen, enhance energy efficiency, and reduce overall energy demand. Turning the top-level research conducted at LIST into practical and disruptive technologies is the cornerstone for a renewed industrial leadership in Europe, all while adhering to the highest environmental standards. This particular technology, developed under the leadership of Dr Emmanuel Defay, represents one of several exceptional contributions from LIST that bolster Luxembourg's reputation as a hub for research-driven innovations with substantial added value for both the country and Europe.”

**About LIST**

The Luxembourg Institute of Science and Technology (LIST) is a research and technology organization (RTO) under the auspices of the Ministry of Higher Education and Research, and its mission is to develop competitive and market-oriented prototypes of products and services for public and private stakeholders.

With nearly 680 employees, 77% of whom are researchers or innovators from all over the world, LIST is active in the fields of information technology, materials, space resources and the environment, and works across the entire innovation chain, from basic and applied research to technology incubation and transfer.

By transforming scientific knowledge into intelligent technologies, data and tools, LIST:

* helps European citizens make informed choices
* helps public authorities make decisions
* encourages companies to develop

For more information about the Luxembourg Institute of Science and Technology, please visit: <https://www.list.lu/>

Press contact:

**LIST**

**Paramita Chakraborty**

Communication Officer

Tel: (+352) 275 888 2237

Email: communication@list.lu