

EFFICIENCY FOR ACCESS RESEARCH AND DEVELOPMENT FUND: INNOVATOR SERIES

PHASE CHANGE MATERIALS: THE FUTURE OF EFFICIENT REFRIGERATION?



THE ISSUE OF GLOBAL FOOD LOSS AND SPOILAGE

[Sustainable Development Goal \(SDG\) 12](#) seeks to address the issue of global food loss and spoilage, which continues to be a significant problem, especially in developing countries. Half of all the food in Africa is lost in the post-harvest stage or before it reaches the market. This is often the result of insufficient access to cooling solutions that keep fruit and vegetables cool in hot African climates

However, in Africa, over 70 percent of the population live without a stable grid connection, which means refrigeration and cold storage are not viable cooling options. In addition, crop yields are falling, due to more extreme weather conditions as a result of climate change, such as droughts, floods and storms. Increasing the amount of food that can be stored and used is more important than ever.

The [Efficiency for Access Off-Grid Refrigeration Technology Roadmap](#) identified priority areas that the [Efficiency for Access Research and Development Fund](#) aims to address. The roadmap recognised small commercial refrigerating appliances that store drinks and foodstuff in retail stores and markets, as a critical investment to help address challenges in the off-grid refrigeration sector.

PCM PRODUCTS' SUST-FRIDGE: COMBATING POST-HARVEST FOOD LOSS

[Phase Change Material \(PCM\) Products](#) is based in UK. For over a decade, the company has been involved in the research, development, production and distribution of Phase Change Material technologies. For this project, PCM Products worked with the University of Nottingham and the Institute of Industrial Research (IIR) in Ghana.

The Efficiency for Access Research and Development Fund supported PCM Products in creating Sust-Fridge, an innovative refrigerator that can keep produce cool for extended periods in off- and weak-grid settings. PCM Products aimed to develop a novel cooling system that was both affordable and efficient, addressing some important issues in the off-grid appliance sector.

End-users live in areas where power outages are frequent or lack access to electricity. Therefore, there is a need for a solar-powered refrigerator that can keep products cool through long periods with no electricity to prevent foods spoiling. The project aimed to bring about substantial benefits to the end user and the wider energy access sector. These include increased economic activity and reduced power demand.

HOW DOES IT WORK?

The project conducted research on a novel refrigeration unit that could be used for food and medical applications. The Sust-Fridge was designed to attain low temperatures in off- and weak-grid settings (e.g., during power cuts or because the power source from PV solar is intermittent). To achieve this, phase change material was incorporated in the refrigerated chamber, alongside a 12V DC micro-compressor and a highly efficient condenser unit.

Phase change materials (PCMs) are substances that can store and release large amounts of latent heat, and are used as an efficient cooling material, without substantially changing the mass of a refrigeration system. Thanks to PCMs incorporated inside its casing, the Sust-Fridge can maintain low temperatures for an additional five hours with no electricity supply, during power cuts or at night.

To improve energy efficiency, PCM Products modified the condenser, reducing the condensing temperature by 10°C. These modifications lowered the start/stop requirement of the compressor, extending the lifetime of the compressor and reducing energy usage. It also reduced the size of batteries required to power the system. As the system needs less power, it means that fewer PV panels are required.

PCM PRODUCTS:

"The Efficiency for Access Research and Development Fund has supported our innovation, which offers the opportunity to develop new, low-cost, and energy efficient refrigeration technology. By minimising post-harvest food loss, farmers can sell more of their products in markets, allowing them to become more productive. This can help lead them to greater profits, more savings and ultimately helping to grow the local economy"

-Zafer Ure, Managing Director, Phase Change Material Products LTD



WHAT DID WE LEARN?

Phase change materials offer a more effective cooling technology for off- and weak-grid settings compared to conventional domestic refrigerators

The developed prototype fridge is able to maintain the desired temperature when combined with PCM containers. IIR tested the PCM cold capacity under real conditions in Ghana, where PCMs were placed inside the cabinet and the compressor was not in use. This showed the effects of incorporating PCMs without any additional power usage. The average cabinet temperature was found to be 11°C, which could be maintained for approximately five hours with no electricity supply. It was also found that the condensing temperature could be reduced to around 10°C.

From PCM Products' research, it can be assumed that 50% of a monthly food shop is perishable if held for prolonged periods above 4.5–7°C. Maintaining low temperatures within the refrigeration chamber during power cuts or at night can help to reduce food spoilage. By reducing the operating power requirements, there is approximately a 40% annual saving on running costs compared to conventional refrigerators, reducing consumption by 110KWh per year.

More consumer education is needed

According to a social acceptance survey conducted during the projects, consumers prioritise refrigerator capacity and brand name over energy efficiency when purchasing a refrigerator. Education, information, and collaboration with known product brands on energy saving technologies is increasing, with projects like Sust-Fridge helping to increase consumer knowledge of these technologies. This can help increase the adoption of more energy efficient refrigerators.

PHASE CHANGE MATERIALS: THE FUTURE OF SUSTAINABLE COOLING?

Climate change continues to increase extreme weather patterns, which will have negative effects on farmers' abilities to produce high crop yields consistently. Phase change materials can help to improve cold storage and refrigeration in developing countries.

Although the application of phase change materials in the off-grid market is at a nascent stage, there are already usage trends emerging. Phase change materials have been successfully integrated into solar-powered air-conditioning units, energy storage systems, heat exchangers and thermal control systems. As they are increasingly adopted into off- and weak-grid refrigeration, phase change materials can help to increase both the affordability and efficiency of refrigeration, helping to combat food loss and spoilage.

GET IN TOUCH:

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