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How the sky can help make air conditioners at least 20% more efficient

By Geoff Smith

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Specially designed fluid-filled roof panels can help make air conditioning significantly more efficient, according to new research.

Could the new invention spell the end of rooftop fans? Christophe Finot/Wikimedia Commons, CC BY-SA

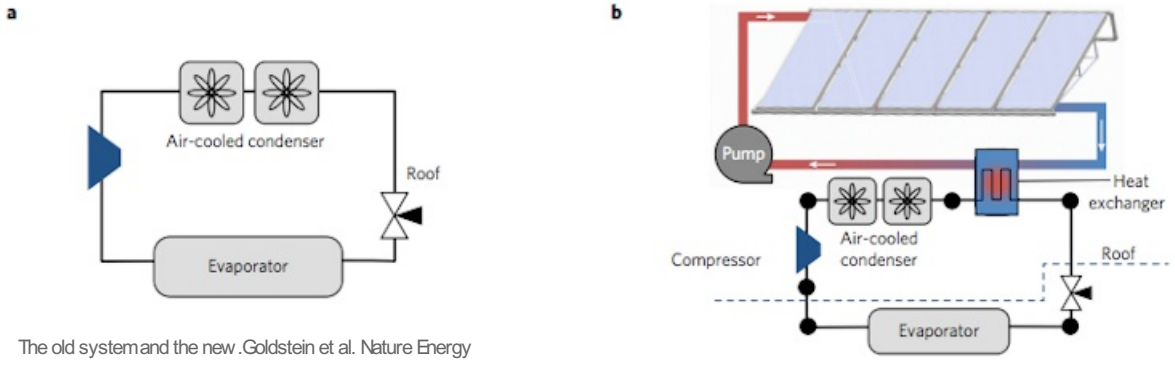
These panels work like solar water heaters, except that they extract heat from the flowing fluid, rather than adding it. This has only been made possible through the development of new, highly reflective materials that allow more heat to be taken out of the fluid than finds its way back in, even in the heat of a sunny day.

As a result, the researchers, led by Eli Goldstein of Stanford University, calculate that these panels, when integrated into an existing air conditioning system, can use 20-50% less power to deliver the same amount of indoor cooling. This in turn could help smooth out demand peaks on the electricity grid in summer, cut energy bills, and reduce the risk of blackouts.

Cool research

For several years, the Stanford researchers and my own group at UTS in Sydney have been trying to design smart roof materials that will help dissipate heat from air conditioning systems more effectively.

Conventional air-conditioning systems get rid of their heat by simply venting hot air from the system's outdoor fan unit. But the new design adds an extra step, using a heat exchanger to pass the normal refrigerant heat into the fluid, which can be either water or glycol. This fluid then flows into the rooftop cooling panels so the heat can be dissipated into the sky.



The old system and the new .Goldstein et al. Nature Energy

The previous problem with this approach was that on hot, sunny days – when you need air conditioning the most – the Sun makes the fluid-filled panels heat up, rather than cool down.

This problem has only been solved in the past three years, with the design of super-reflective surfaces that can repel 97% of the incoming solar energy.

Feeling the heat

Nearly all synthetic and natural surfaces absorb at least 5% of incident solar heat. Even the best white roof paints typically absorb more than 10% of the Sun's heat. The best-performing surface is a shiny, flawless layer of silver, but that doesn't last very long in outdoor conditions.

But what if we can protect the silver, and maybe even improve its reflective performance by placing it under a layer that also helps to reflect solar energy? Three research groups came up with possible solutions, two involving plastic coverings for the silver, and the third involving a complex layering of different oxide materials.

At UTS, our approach involved using many layers of two different plastics, placed on top of the silver. The resulting material reflects 97% of the incident solar energy, repelling the sun's heat so effectively that the fluid inside cools down, even on a hot day.

Look to the skies

As the new Stanford research confirms, these super-reflective surfaces can perform a neat trick: getting the rooftop to lose heat during the day in the same way it does on a clear night. On clear nights, upward-facing surfaces can drop to several degrees below the ambient temperature because their heat dissipates high into the sky. The new super-cool roof panels do the same in the daytime as well. For example, they can condense dew well after sunrise even though the outdoor air temperature is above the dew point.

The panels can easily be retrofitted onto existing air-conditioning systems, ultimately saving money in the long run because of the reduced energy use. By modelling their system's performance, the Stanford researchers calculate that the panels could reduce air-conditioning costs by 21% for a typical two-storey building in the sunny climate of Las Vegas.

These kind of hybrid systems could become commonplace, combining existing indoor air-conditioning technology with the new panels shedding the heat directly upwards into the sky. If you'll pardon the pun, things are really looking up for those aiming to bring their energy bills down.

ABOUT THE AUTHOR

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