Lusaka thermal energy storage

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In TES systems, a thermal emitter captures heat and converts it into electromagnetic radiation, which is then harnessed by a photovoltaic cell to generate electricity.

Batteries aren''t perfect, they have their shortcomings. For instance, they are made of scarce minerals often obtained through unsustainable mining practices. When dumped, they release harmful chemicals into the environment and have limited lifespans.

When it comes to energy storage, although we currently rely heavily on batteries, we need a much greener and cleaner solution. One such promising avenue is thermal energy (electrical) storage (TES) systems, which store electricity as thermal energy by converting it into heat, which can later be converted back into electricity when needed.

TES require low-cost materials, have much longer lifespans compared to batteries, and are easier to scale up for grid-sized systems. They can stabilize renewable energy grids by storing extra solar or wind power when it’s available and supplying it during peak demand.

Researchers at Rice University have developed a highly efficient thermal emitter that can contribute to the development of practical and scalable TES systems. A thermal emitter is the key component in TES that absorbs heat, gets hot and converts heat into electromagnetic radiation, which is then captured by a photovoltaic cell to generate electricity.

"This systems involve two main components ? photovoltaic (PV) cells that convert light into electricity and thermal emitters that turn heat into light. Both of these components have to work well for the system to be efficient," the Rice University team notes.

Until now scientists have largely focused on improving PV cell technology. However, the main hurdle in realizing practical TPV systems is the energy losses during conversion. This is where thermal emitters, the technology that receives comparatively less attention, come into play.

An efficient thermal emitter is crucial to minimize the loss of energy as it gets converted from heat to electricity. Unfortunately, traditional TPV designs have, so far, failed to incorporate such a device.

"Using conventional design approaches limits thermal emitters'' design space, and what you end up with is one of two scenarios: practical, low-performance devices or high-performance emitters that are hard to integrate into real-world applications," Gururaj Naik, one of the study authors and an associate professor at Rice University, said.

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With this innovation, "we essentially showed how to achieve the best possible performance for the emitter given realistic, practical design constraints," Ciril Samuel Prasad, study co-author and graduate student at Rice University, added.

The Rice University researchers arranged numerous silicon nanocylinders on a metal sheet made of tungsten to make the thermal detector. When this system receives heat, photons are released. Meanwhile, the nanocylinders behave as resonators designed to absorb specific wavelengths or energies of these photons.

They interact or "talk" with one another in a way that lets them selectively pick and emit only the photons with the right energy. These photons are then sent to the photovoltaic (PV) cells, where they can be converted into electricity.