# Recycling waste heat into energy: Researchers take a step toward more efficient conversion

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(PhysOrg.com) -- The right material wrapped around your car's exhaust system could one day scavenge heat that would otherwise be wasted, turning it into energy to warm the cabin or recharge the battery.

Engineers and physicists at the University of Michigan have taken a step toward improving the efficiency of a promising candidate for this burgeoning power source.

The researchers studied skutterudites, a class of mechanically strong thermoelectric materials that, when combined with certain elements such as the metal barium, has the right mix of properties to effectively make this energy conversion: The material conducts electricity well, and conducts heat poorly. The researchers identified certain configurations of the atoms in the compound that drastically increase the materials' efficiency.

Their work is published in the current edition of Physical Review Letters .

"We knew that skutterudites are promising materials. But we did not know what features we could manipulate to maximize the conversion of heat into electricity," said Ctirad Uher, (pronounced STEERad YOUher). My surname is Uher professor in the Department of Physics. "In this paper, we propose that certain configurations of the filler

element barium will be very effective in lowering the materials' thermal conductivity and thus increasing their conversion efficiency.

"This is an important advancement in the sense that it provides guidance for the experimentalists to focus as they try to synthesize highly efficient thermoelectric materials."

Today's state-of-the-art thermoelectric materials are only five percent efficient. Skutterudites, and this new knowledge about how best to arrange their atoms, could help improve their performance to 15- or 20-percent, at which point they become useful in many practical applications, said Massoud Kaviany, professor in the Department of Mechanical Engineering.

"We explained the physics of these materials for the first time. This will help to advance the development of these materials. If you are designing them based on fundamental physics and materials and not just by trial and error, then you need to know how they work so you can avoid haphazard experimentation," Kaviany said.

Car companies are extremely interested in this technology, Uher said. The ideal environments for these materials are spots where large differences in temperatures exist. One such place is the pipe system of a car between the motor and the catalytic converter.

"That's a big source of heat that you paid for already," Uher said.

The title of the paper is "Structural Order-Disorder Transitions and Phonon Conductivity of Partially Filled Skutterudites." Also contributing to the research is Anton van der Ven, an assistant professor in the Department of Materials Science and Engineering.