

# Recuperating waste heat under the hood

July 9 2014, by Anne-Muriel Brouet

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Credit: Alain Herzog

For his semester project in mechanical engineering, Elliott Guenat studied the best way to recuperate waste heat from a car's engine. The challenge is figuring out how to incorporate the heat exchangers micro-turbomachines.

Elliott Guenat, a first year master's student in [mechanical engineering](#), isn't a priori all that interested in SUVs and big rigs. But his passion for [thermodynamics](#) and his interest in [environmental issues](#) have given him a reason to take a look under their hoods. He has emerged with plans for a thermomechanical system that can produce electricity from the waste heat of [tailpipe emissions](#) and cooling [fluids](#).

In spite of the efforts of [automobile manufacturers](#), nearly 70% of the fuel consumption is dissipated as heat into the environment. The

problem is that the temperature of the [waste heat](#) is too low to be converted in a useful manner.

However, there is a thermodynamic system that can exploit these differences in temperature to produce electricity: the Organic Rankine Cycle (ORC). It's currently only used in recuperating industrial heat (in cement production), biomass production and geothermal energy applications. The ORC operates similarly to a [steam engine](#), except that the water is replaced by an organic fluid such as propane. Pumped within a hermetically sealed circuit, the fluid is heated and evaporated, then passed through a turbine, then condensed back into liquid form to start the cycle over again.

None of the car manufacturers have managed to incorporate this kind of system in a commercialized vehicle. Promising research on micro-turbomachinery led Guenat, who is supervised by Jürg Schiffmann in the Laboratory of Applied Mechanical Design (LAMD), to study the possibility of using it in vehicles and explore the conditions in which it could be applied.

## **Potential for truck transport**

The theory indicates that micro-turbomachines could be the answer, but not for just any vehicle. "For a compact car like those manufactured today, it's difficult," says the student. The biggest obstacle is finding room for the exchangers, which have a 40-liter volume (the size of a big microwave oven). The entire vehicle would have to be redesigned to incorporate them, keeping in mind that the bigger they are, the better they'll work. In addition, the vehicle must generate enough heat to make the process worthwhile, which would typically only be the case in freeway driving.

Thus the vehicles that would benefit the most from a system like this are

big ones like trucks or buses. "The theoretical model shows that with the concept we studied, one could gain 8 energy efficiency points, the equivalent of reducing fuel consumption by a quarter to a third," says Guenat. The gain could be used to provide more power to the engine, to keep the engine at a constant speed, to air-condition the cab, or to power a refrigerated compartment. "It's still early days for the development of small-scale low-temperature applications," says Guenat, who's spending his summer delving deeper into applications of his research in trucks, in the LAMD.

Provided by Ecole Polytechnique Federale de Lausanne

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