Engineering new vehicle powertrains

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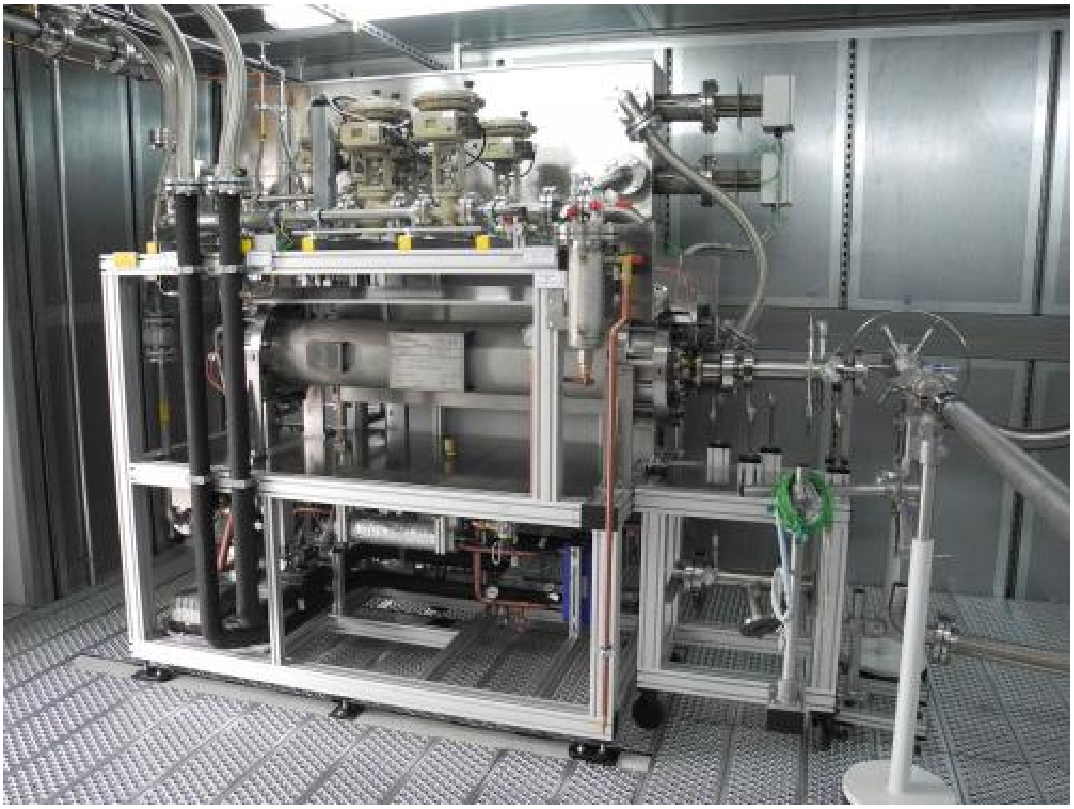

Researchers at a new hot gas test facility are testing the waste heat use systems and turbo-chargers. Their goal is to develop more efficient powertrain concepts for passenger vehicles and trucks. Credit: Fraunhofer ICT

Car engines – whether driven by gasoline, diesel, or electricity – waste an abundance of energy. Researchers are working on ways to stem this wastefulness. Ultramodern test facilities are helping them to optimize the entire development process of the engine. In the laboratory, they have already raised the degree of efficiency by up to ten percent.

Trucks, cars and motorcycles are energy-guzzlers: over 60 percent of the energy generated in their engines by fuel is lost through the exhaust gas and the coolant. The biggest part of this simply slips off into the environment as heat. Beneath our engine hoods, gasoline, diesel and electricity are wasted and unnecessarily pumped into the air through the exhaust system as CO2," says Dr. Hans-Peter Kollmeier, from the Fraunhofer Institute for Chemical Technology ICT in Karlsruhe. The "new drive systems" project group is probing the causes for this kind of waste. Together with other researchers, it is developing efficient drive concepts for vehicles. In the laboratory, they have already succeeded in increasing the degree of efficiency of car engines by five percent, and up to ten percent for commercial vehicle powertrains.

The scientists have new test facilities available since this summer. "At the Karlsruhe location, we were able to map the entire process of powertrain development: from design to simulation and to testing," says Kollmeier. The researcher's goal is to optimize the technologies of the drivetrain being utilized, so that the fuel savings is optimal. For this purpose, you must know how the individual components interact with each other in reality. "With the new testing options, we have come one huge step closer to this goal. Through this effort, we have the opportunity to test the drivetrain as a whole, and validate our simulations," says Kollmeier.

The linchpin of this new test infrastructure is an engine and hot gas test stand. There, researchers can analyze engines and their components both mechanically and thermodynamically. A computer controls the systems and simulates realistic application scenarios. For example, the computer can additionally switch on virtual hybrid drives (like electric motors) or systems that use waste heat. The scientists analyze how the vehicle drive acts with regard to fuel consumption and CO2 emissions. For this purpose, Kollmeier's team simulated vehicle in terms of type, route, or driver methods accordingly. Once sufficient data are gathered, the researchers build prototypes and then gradually substitute the simulation models through real components in the test facility. Step by step, they are thus arriving at the optimal powertrain. In the process, lightweight materials become increasingly important.

If it is about making car engines more efficient, then the term "downsizing" comes into play. Generally speaking, it is minimizing the displacement of the engine, without reducing its performance capacity. Through the diminished friction resistance and the improved thermodynamic process, we can reduce fuel consumption and CO_2 emissions. As a rule, turbo-chargers are used in downsizing concepts, which are integrated into the suction and exhaust tract. These screw-shaped components – about 15 centimeters in cars – suck up air and push it into the internal combustion engine. Thus, more fresh air is conducted to the engine, which allows for a greater quantity of fuel to be consumed. Due to the higher cylinder pressure that this reaches, higher engine power is also achieved for the same engine displacement. The turbocharger is driven by the exhaust gas of the vehicle. At the hot gas test facility, the scientists are testing their turbo-chargers. At this facility, a certain exhaust gas mass power is generated by a natural gas burner which corresponds to that of an internal combustion engine. The burner can be set very precisely, in order to analyze how the most miniscule changes to peripheral conditions affect the turbo chargers.

"The turbo charger is the classic approach to improving the degree of efficiency of an engine. You use a portion of the energy that is deflagrated through the exhaust. But it is also subject to limits. Steam power cycles can be helpful here for example," says Kollmeier's colleague Dr. Sascha Merkel. In doing so, a fluid working medium (e.g., water or ethanol) is heated by the waste heat. It evaporates and drives small turbines that will, in turn, generate mechanical energy. The gain can then be transferred directly to the crankshaft or converted by a generator into electrical energy, in order to supply them into the new power circuit, e.g. in the vehicle's electrical system. At the hot gas test facility, scientists are studying how individual components of a mini-power plant behave under various framework conditions.

The scientists are closely networked with other powertrain experts from research institutions and the development departments of automakers. "Of course, contact with the automotive industry in particular is immense. This development of the powertrain concepts runs in close coordination with carmakers. The direct application of the research findings in the practice is at the forefront," explains Kollmeier.

Provided by Fraunhofer-Gesellschaft

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