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The free piston linear generator

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The free piston linear generator (FPLG) is a compact electricity generation unit, which is being developed since the year 2003 at the German Aerospace Center (DLR). It is designed as a free-piston combustion engine with integrated linear generator. This combination allows for highly efficient conversion of the chemical energy stored in a fuel to electrical energy.

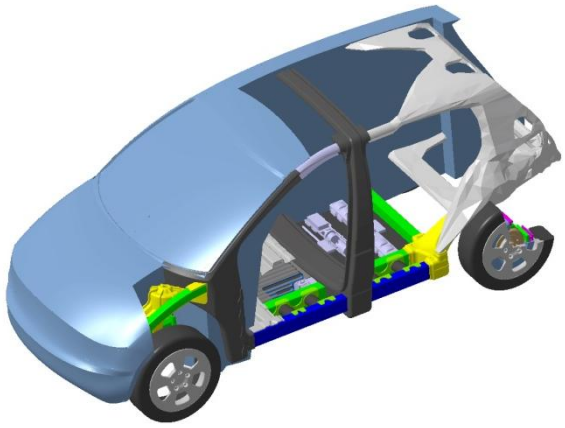

Fig. 1 Vehicle concept with DLR technologies, including free piston linear generator

The concept is of high interest for electrification of drivetrains for future road vehicles. Applied as a range-extender-unit, it provides additional electric energy to electric vehicles in case of discharged batteries. In addition to this automotive application, the FPLG could be used as an auxiliary power unit for example in aircrafts as well as in decentral combined heat and power stations (CHP).

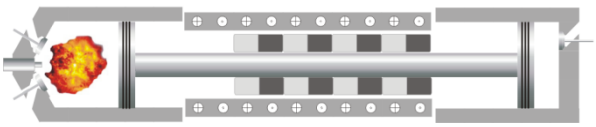

Fig. 2 Schematic diagram of FPLG

The FPLG consists of three main components. In the combustion section the fuel-air mixture is burnt and a piston is accelerated. The second component, the linear generator consists of electromagnetic coils as a stator and permanent magnets as a rotor. The latter is rigidly attached to the combustion piston. The resulting relative linear motion between stator and rotor generates electric power. The gas spring as the third component is necessary as a temporary energy storage and in order to decelerate the piston and revert its motion. Due to its variable stiffness, it serves as an actuating variable of the system.

As the device does not include a crankshaft, the piston motion is free and can be actively varied by controlling the linear generator force, combustion parameters and the gas spring pressure. It is possible to influence the piston trajectory as well as the stroke and the compression ratio. These features lead to a potentially high part load efficiency of the engine. In addition, different fuels can all be burnt in the same engine without any efficiency losses.

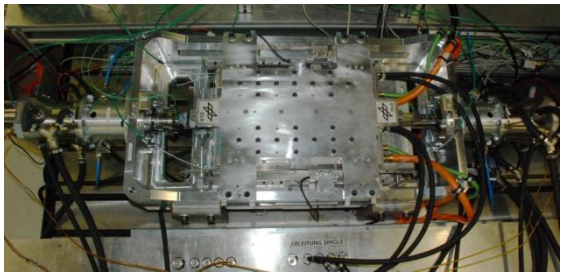

Fig. 3 Test stand with the function demonstrator

DLR is developing a function demonstrator prototype and is aiming to perform the proof of concept. In the last years, the three components were developed with the help of a highly dynamic hydraulic actuator that actively moves the piston and the rotor, respectively. Separately all three components are operational and have been analyzed in the past years. Measurement results are promising. Also, an overall system including the three components plus the hydraulic actuator has been taken into operation in 2011. Current work is dedicated to enabling the system to work without any external (hydraulic) actuator on the one hand and to advance the combustion section. As an exceptionally effective combustion process, homogenous compression charge ignition (HCCI) will be implemented on the test stand.

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