Department of
ENERGY TECHNOLOGY E.T.

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# Fuel Cell Range Extender

A methanol fuelled range extender was developed and tested. The range extender employs a High Temperature Proton Exchange Membrane (HTPEM) fuel cell combined with a methanol reformer. The range extender can enable a driving range of 600 km of the New European Drive Cycle (NEDC) and fast refuelling. The fuel cell system demonstrated an electric efficiency of around 32%.

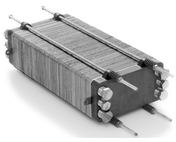


Fig. 2: HTPEM fuel cell for range extender.

## Fuel Cell Range Extender

A range extender is an onboard device that charges the batteries to extend the driving range beyond that of the battery pack alone. In the current work, the system consists of a methanol reformer and a high temperature PEM fuel cell. The developed range extender was demonstrated in the laboratory using the setup show in Fig. 1.

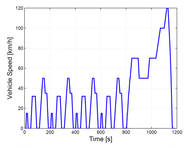



Fig. 3: Drive cycle used in laboratory tests.

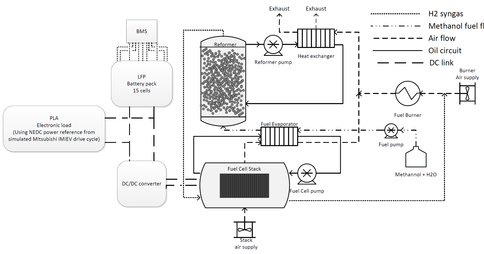



Fig. 1: Fuel cell range extender and battery pack.

To avoid substantial integration work, the range extender was not installed in the AAUDI. An electronic load was used to simulate the power consumption during a standardized drive cycle (Fig. 3). The power consumption was established using a mathematical drive cycle simulation program. To reduce the required range extender power and battery pack capacity, the power consumption was down-scaled to a peak power of about 16 kW and an average power of around 1.7 kW. The fuel cell based range extender was capable of delivering the average power and the battery pack provided the peak power.

## Results

Measured power consumption profiles from the battery with and without the fuel cell range extender are shown in Fig. 4. The graph includes 2 NEDC cycles. It is seen that, the fuel cell range extender offsets the power consumption by about 1,7 kW. The range of the vehicle is only limited by the capacity of the fuel tank. However, at high continuous speed (for example motorway driving), the battery pack will be discharged. When this happens, the maximum speed will be limited by the range extender power output.

The electric power production efficiency of the fuel cell stack was about 37% and with the system auxiliary losses an overall electric efficiency of about 32% was achieved (Fig. 5).

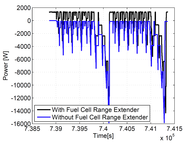



Fig. 4: System power consumption profiles

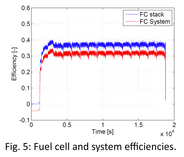
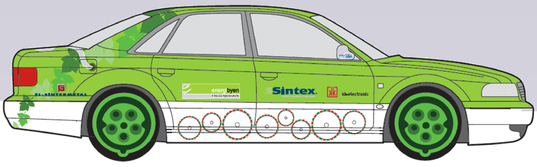



Fig. 5: Fuel cell and system efficiencies.

## Outlook

The laboratory prototype testing demonstrated the feasibility of the technology. The combination of batteries with a fuel cell range extender offers many advantages over each of the technologies alone. The fuel cell greatly extends the energy density of the combined system and keeps the batteries within the preferred state-of-charge window. The batteries protect the fuel cell from the highly dynamic load profile which greatly extends its expected lifetime.

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