Efficient Use of Resources in Energy Converting Applications

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The use of micro-combined heat and power (Micro-CHP) (Fig.1) devices will become more and more popular as a decentralized power and heat supply for present and future. It is one of the most efficient principals for utilization of energy content fuels, whether fossil or renewable. There are a lot of advantages (1) for Micro-CHP systems like high overall efficiency, possible grid independency, and flexibility in the supply on demand. In any case, there are research aspects that have to be taken into account.

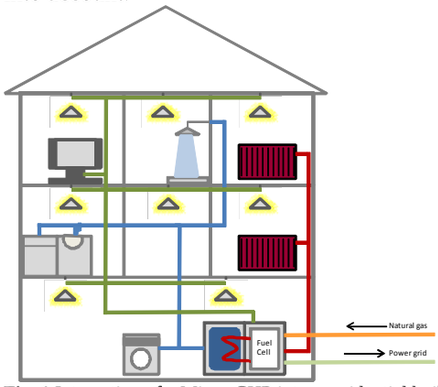

Fig. 1 Integration of a Micro-CHP into a residential building.

Fuel Cells are energy converter where the oxidation of the fuel takes place without losses; the chemical energy is directly converted into electrical power. Due to this, the efficiencies are much higher compared to those processes, which are limited by the Carnot Cycle.
Combining fuel cells and Micro-CHPs on can use the advantages of both technologies. Here the first results of a European project developing a middle temperature proton exchange membrane fuel cell (MT-PEM FC) for application in Micro-CHPs, to overcome the disadvantages like complex gas purification, humidification, and the low temperature gradient for the heat exchanging system, are presented.
The optimization includes the improvement of operating conditions. Therefore the suggested protocols from a former European project called FCTES^{QA} (Fuel Cell Testing, Safety & Quality Assurance) (2) were applied for commercially available LT-PEM stacks. Several parameter may influence the efficiency of FC stacks, the variation of parameters like pressure (Fig.2), temperature (Fig. 3), and stoichiometry (Fig.4) are applied to improve the stack efficiency.

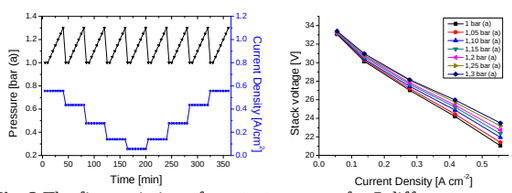

Fig. 2 The five variation of reactant pressure for 5 different current set point at defined current densities for the chosen FC stack (left) and the resulting polarization curves showing an increase with increasing pressure.

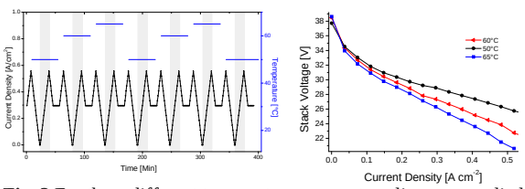

Fig. 3 For three different temperatures current cycling was applied therefore current densities from 10 to 100% of the nominal current of the stack were applied (left). A decrease of the efficiencies with increasing temperature can be observed (right).

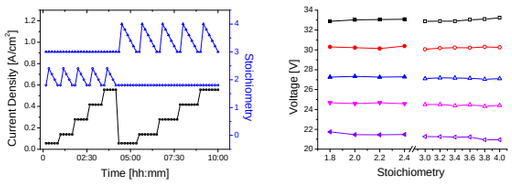

Fig. 4 In the first cycle the stoichiometry for the anode was changed whereas cathode was held stable at different current set points. In the second cycle it was the other way around (left). For the applied variation no changes in the voltage were observed (right).

Using the results and apply optimized parameters for the same stack a voltage increase of 8 % at the nominal current (15 A) has been measured (Fig.5).

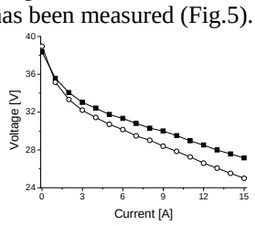

Fig. 5 Polarization curves with basic parameters (○) and optimized parameter (■) of a commercially available PEM FC stack.

The outcome of operation parameters variation show up a physical behavior and influences on fuel cells and fuel cell stacks during operation. Defined test methods allow the comparison of stack performances and degradation rates at individual places. With detailed understanding of the MEA degradation, especially by decomposition and poising effects, it is possible to perform short-term test and evaluate the long-term stability regarding application profiles for Micro-CHP system. In the near future we expect a more robust and less complicated system with competitive costs.

Acknowledgements
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Literature

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2. http://fctesqa.jrc.ec.europa.eu/Nnn