Biogas fueled Solid Oxide Fuel Cells

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Due to the increasing amount of renewable energy in the power network different energy conversion and storage technologies are needed to balance the fluctuations in the grid. One attractive storage medium is fuel derived from biomass. However, given that biomass is a raw resource one should bear in mind that food production has first priority. Hence fuel derived from biomass, like biogas, has to be used in an efficient way. Whereas in commercial biogas power plants biogas is burned off with low efficient combustion engines, solid oxide fuel cells (SOFC's) could be a more efficient alternative. Furthermore most biogases are unattractive for combustion engines due to their low heating values. With SOFC's, which can be operated at temperatures between 700°C and 1000°C, it is possible to convert hydrogen or carbon containing fuels, as for example biogas, directly into electricity and the side product heat in a highly efficient way (see fig. 1).

Biogas consists mainly of CH_4 (50-70%) and CO_2 (30-50%) and some traces of other gases such as sulfur compounds. Due to the nickel containing anode of the SOFC internal reforming of CH_4 is possible and thus a direct feeding of biogas. To prevent carbon formations during this process an additional reforming agent like CO_2 (which biogas already contains) or steam has to be considered.

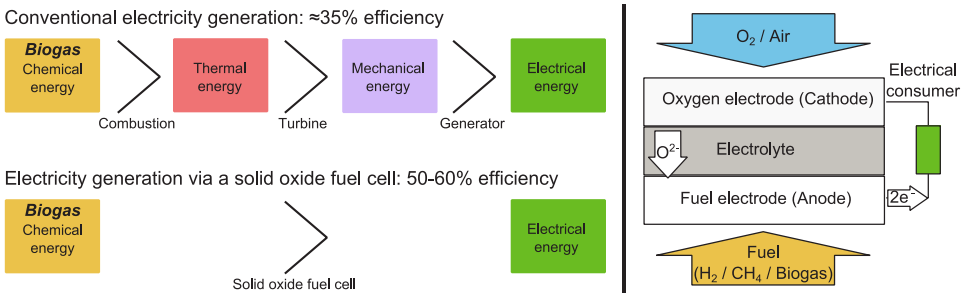

Figure 1: Electricity generation options from biogas (left). Working principle of a SOFC (right).

Experimental results (fig. 2) show that it is possible to operate a SOFC with pre-mixed biogas and the use of the internal reforming process of CH_4.

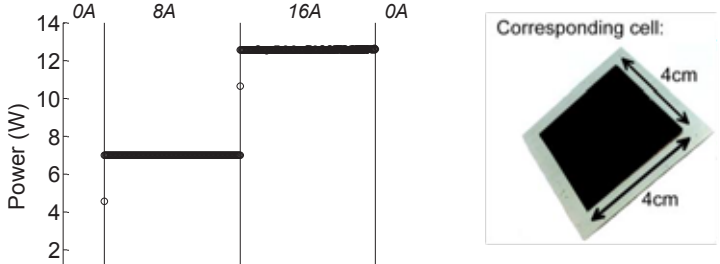

Figure 2: Power of a pre-mixed biogas (60% CH_4, 40% CO_2) fueled SOFC with a current up to 16A at 850°C. Anode gas composition: 50% biogas, 40% H_2O and 10% H_2. Cathode gas: Air.