**Small-scale fuel cells to facilitate integration fluctuating power sources**

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With ambitious targets for expansion of wind power in many countries, a primary concern is the intermittent nature of energy source. While it has been demonstrated in e.g. Denmark that more than 20% of the total electricity demand may be covered by wind power, it is becoming apparent energy systems need to be very flexible to accommodate higher shares. Cogeneration of heat and power (CHP) systems are used actively in Denmark to integrate wind power, but in countries without district heating, this was not an option before the advent of very small CHP plants for individual dwellings. The introduction of fuel-cell-based micro-CHP systems for individual houses thus constitute a possibility for expanding wind power and can thus form an important element in a transition towards renewable energy systems. This naturally requires that the fuel used is produced based on renewable energy sources – e.g. hydrogen from wind power, or ethanol, methanol biogas from biomass resources. In the context of wind power integration, reversible fuels cells producing and consuming hydrogen is particularly interesting as it gives downward as well as upward regulation capability.

Fuel cells have often seen as a means to switching transportation to renewable energy using hydrogen as an intermediary energy carrier. While indeed important in the transportation sector, stationary applications are also emerging; applications where fuel cells are applied to supply individual houses with electricity and as a by-product heating. The EU supported RES FC Market project has investigated barriers and preconditions for such applications in Denmark, Netherlands, Germany, Portugal, Spain and Iceland, and while the efficiency-to-cost ratio is still modest, there are possibilities also for stationary applications. In order to optimise the economy, there needs to be a heat demand where the fuel cell is installed, and electricity markets with widely fluctuating prices are also required. The ability of the fuels cells to supply regulating power is also an element that gives added value to the investment. However, public regulation in most European countries do not accommodate such small producers of power and regulating power. Technical changes in the energy systems must thus be accommodated by institutional changes.

There are also needs in term of developing the technology. Costs and life expectancies are still to be improved. Generally, it is desired that the life expectancy of the fuel cell unit should be at least 40,000 hours, but most units hardly reach 10,000 hours of operation.

In Denmark, there is an aim that in 2012, commercially available mass-produced 1.5 $kW_e$ domestic fuel cell units should drop to a price of approximately 4000 € for units run on pure hydrogen or 5300 € for units operated on natural gas. These prices are comparable to the price level of new oil furnaces for house heating, though these have higher heat outputs. Such units will thus require better insulated houses.

Ambitions like these are in the process of being met through actual technology development and a number of field test being conducted worldwide. In Denmark, a 7 million € demonstration project is underway focusing on national technology development and testing three different technologies operating on natural gas and hydrogen. German Baxi using Danish IRD Fuel Cell’s low temperature PEM technology has conducted field test for some years, and Tokyo Gas has a very large project with more technologies and 1000s of units being field-tested.

With technology development progressing and barriers for their implementation being identified, fuel cells may thus one form an important element in the energy system.


FC system for single house. IRD Fuel Cells, Denmark

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| Electrical Power | Nominal: 1.5 kW_AC; Range: 0.5-2.0 kW_AC |
| Heating: | Nominal: 1.5 kW; Range: 0.5-3.0 kW |
| Efficiency: | Electrical: >45%; Combined: > 80% |
| Technology | PEM Fuel Cells |
| Life expectancy | Not tested at systems level |

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