APPLICATIONS WITH PROTONE EXCHANGE MEMBRANE (PEM) - FUEL CELL SYSTEMS FOR HEAT AND ELECTRICITY GENERATION IN A DEREGULATED ENERGY MARKET"

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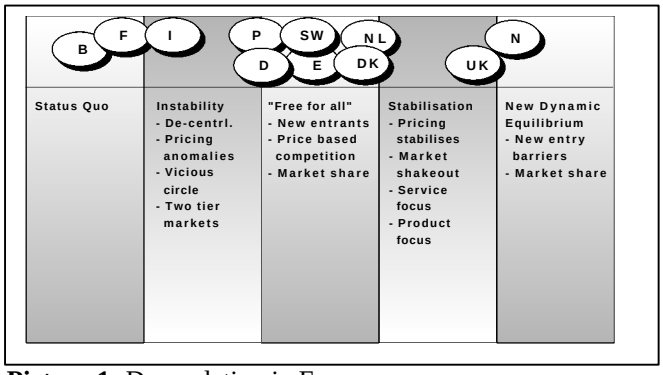
Abstract

The electric utility is in a period of rapid change. The deregulation and restructuring of the utilities will lead to massive industry change with new structures of energy supply. This market change creates a significant opportunity for fuel cells as on-site generation solutions.
This paper considers the recent development in applications of Proton Exchange Membrane Fuel Cells (PEMFC), in particular for premium power applications, industrial and commercial distributed power plants, and for clients of independent power supplies.
Fuel cell systems are distinguished according to different factors: the type of electrolytes used, operating temperature and stage of development at present.
Low temperature fuel cells are well suited for decentralized power supply. Positive experience has already been gathered with fuel cells in combined heat and power systems (CHP). CHPs do not only generate electricity with a high electrical degree of efficiency, they also produce heat which can be employed efficiently locally, so that a total degree of efficiency of more than 80% is reached. Of importance here is the linkage of the heating system and the layout of the system as a whole. Production of cooling via heat by way of adsorption-cooling-systems operating at temperatures below 100°C have the advantage of achieving high annual operating hours of the modules.
PEMFC will, in the near future, be used in the automotive industry and also in distributed power supply with an heat demand of 80°C. Due to its excellent dynamic characteristics PEMFC can be used as emergency generating set for customer who have special requirements for their critical equipment in case of power interruptions in the public electricity supply. This, however, requires the fulfilment of very detailed specifications concerning the grid connections. The bridging time is defined by the size of the hydrogen storage. The quality problems of normal electricity experienced by commercial and small industrial users, applications that provide high quality, reliable electricity are becoming increasingly popular.
Employment of this technology in housing areas for electricity and heat generation will be possible in the future, when the costs of production have been greatly reduced. General introduction to the market at a large scale is dependant on reasonable costs, and the chances for cost degression of PEMFC are highest through employment in various market sectors and thus will be achieved the fastest of all known fuel cell systems.

1. Introduction

The electric utility industry is in a period of rapid change. Deregulation, liberalisation, wholesale and retail wheeling are quickly becoming realities as legislation to end the electric utility monopolies on the sale of electricity, is introduced world-wide, see as an example for Europe picture 1.



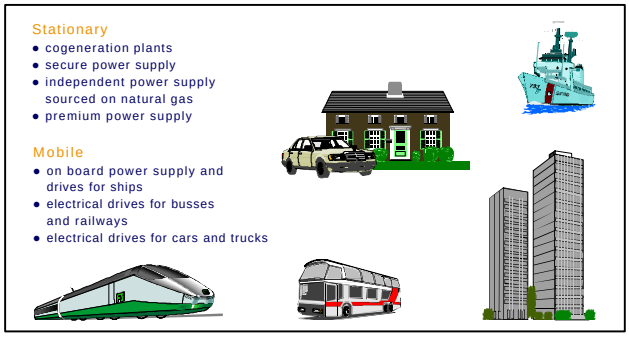
Picture 1: Deregulation in Europe

Today's electric utilities, accustomed to captive consumers through regulated service territories, are entering a changed business environment as they face competition for customers.

They have to create high quality customer service in order to create a competitive advantage that will retain and hopefully increase their customer's base.

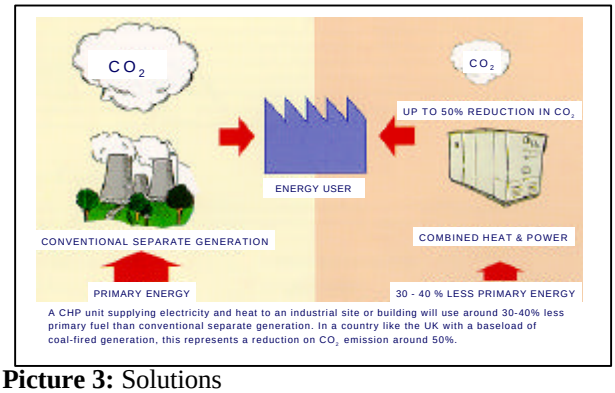
As a result of all this:
They must learn to keep the customer. Competitive markets and trading products need innovative, new technologies. One of them should be the "Proton Exchange Membrane Fuel Cell" (PEMFC).

As shown in picture 2, this fuel cell has a high number of applications in the field of stationary power plants and mobile devices.



Picture 2: Applications of the PEM-FC

Because of their modularity efficiency and environmental benefits, PEM - Fuel Cells are a favoured solution to implement distributed power concepts as shown in picture 3.



Picture 3: Solutions

2. Strategic Fuel Cell market opportunities

The vision has been promoted for the following strategic Fuel Cell markets:

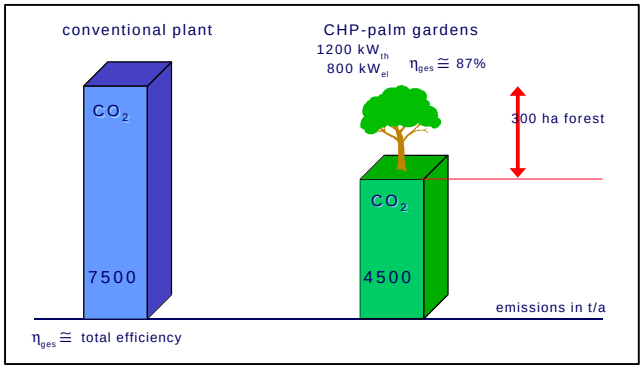
- Cogeneration Plants
- Secure Energy Supply
- Premium Power Supply

2.1. Cogeneration Plants

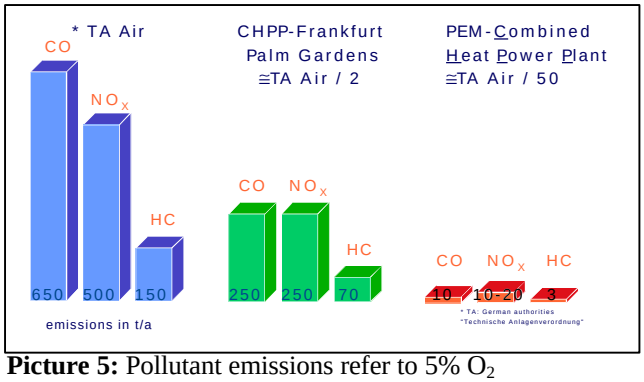
Combined Heat and Power (CHP) capacity is growing rapidly throughout many European Union (EU) member countries as private and public enterprises recognise its benefits as a flexible and economic energy source. Its high overall efficiency compared to separate generation brings a significant reduction in carbon dioxide (CO_2) emission and more efficient use of fuel. Many national energy strategies are encouraging tale up of CHP as a key part of international commitments to climate change initiatives.

Increasing use of CHP does have other environmental implications. In particular, emission of nitrogen oxides (NO_x) and carbon monoxide (CO) can rise and specific legislation has been enacted in many countries to set limits for the release of these pollutants from CHP systems.

CHP has an overall efficiency of around 85-95%. This is often around 30-40% greater than separate fossil fuel based generation and brings an accompanying reduction of 30-40% in primary fuel consumption and CO_2 emission. (Pictures 4 and 5)



Picture 4: Reduction of CO_2 emissions



Picture 5: Pollutant emissions refer to 5% O_2

A common problem of all cogeneration applications is to find clients with such big heat demands. This is one of the advantages of the PEM - Fuel Cell. Moreover, as the Fuel Cell Power Plant is a high electrical efficiency generator, its relative back of waste heat may actually restrict its suitability for the classic cogeneration customer.

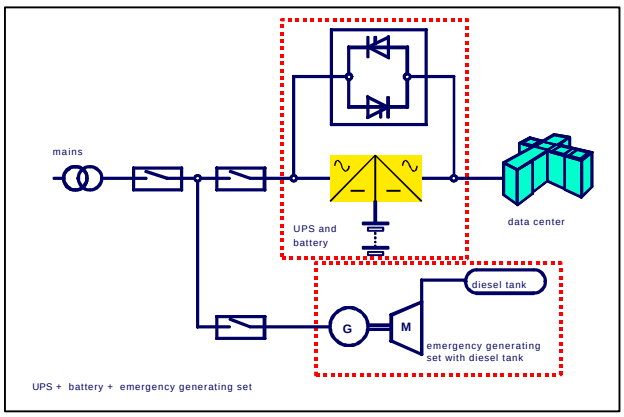
The Fuel Cell Power Plant should be looked at the other way around. Rather than a heat source with some electricity, it is an electricity source which can be used for cogeneration applications. This opens doors and should increase the prospects for the above mentioned future markets.

2.2. Secure Energy Supply

Providing high availability of power is one method of creating value for electric consumers. In accordance to the necessities of such consumers the system for secure energy supply works with a stand-by function in case of failures of the grid.

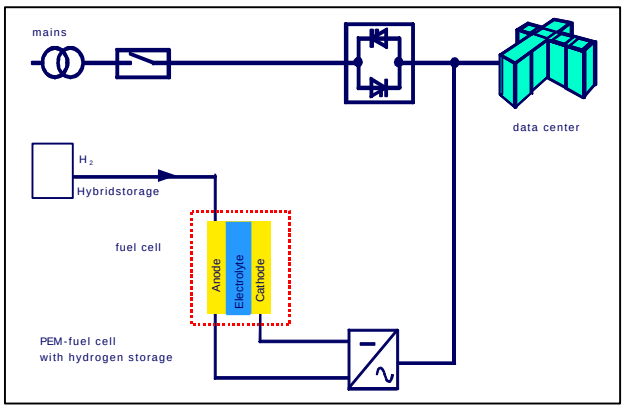
The components to achieve this stand-by power are a UPS (Uninterruptible Power Supply) and a EGS (Emergency Generating Set).

If the grid fails the load is picked up (or bridged) by the UPS until the EGS can come on line.



Picture 6: Principle structure of a convential system

The future solution based on the PEM - Fuel Cell is shown in picture 7.



Picture 7: Principle structure of a PEMFC system

2.3. Premium Power Supply

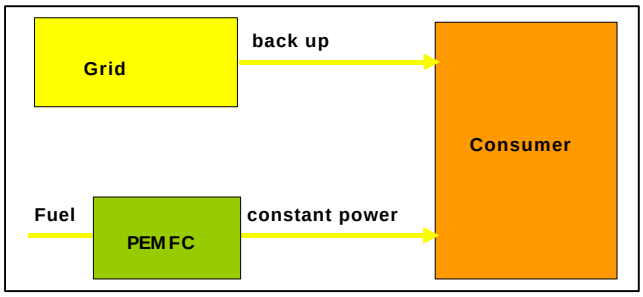
Power quality issues are receiving significant attention worldwide and many utilities are seeking solutions to improve the power quality their customers receive.

Power quality is one aspect of power value, a concept which is going wide recognition. The basis of the power value concept is that customers should be able to address their power needs through the appropriate selection of price, reliability, quality, etc.

Under the conventional regulated system, customers have not such a choice and it is virtually impossible to provide power value solutions without using on-site power.

Due to the quality problems experienced by commercial and small industrial users, applications that provide high quality, reliable electricity are becoming increasingly popular.

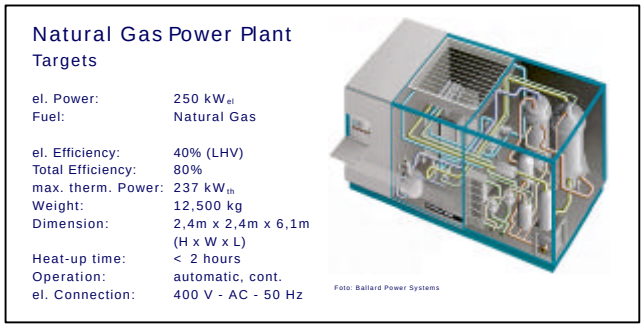
These applications ensure that the load receives constant power by the PEM - Fuel Cell and using the grid per back up power in the event of a power plant out.



Picture 8: Grid and PEMFC

In the Secure Power Supply or Premium Power installation envisioned with a Fuel Cell Power Plant, the Fuel Cell provides primary power for sensitive loads and is backed up by the grid; while the grid provides primary power to the non-sensitive loads.

The customer is able to extract the best of both worlds - grid and distributed generation for a true tailored solution. These strengths allow Fuel Cell power plants to provide an ideal system for the large market for Premium Power applications.



Picture 9: Pilot Plant