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Not cost minimisation but added value maximisation

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Abstract

Fuel cells are on the verge of market entry aiming at replacing long established conventional electricity generation and propulsion technologies. Upon entrance to the first markets the necessarily higher costs will need to be offset by added value to the consumer. Examples, discussed here, indicate that generally speaking the highest additional cost margins will be achievable through lifestyle oriented issues, recreational applications and from remote power. Fuel cell's potential environmental superiority results in a high acceptance in public opinion, but, needs to be clearly proven in all aspects from fuel supply to operation and recycling. Only if the added value and environmental performance are convincingly displayed will fuel cells be able to claim a substantial part of their potential market.

Keywords: Fuel cell; Market adoption

1. Background

Fuel cells constitute an energy conversion technology that has the potential for achieving a considerable increase in energy efficiency in many areas of energy utilisation over the next decades. They introduce a novel approach to electric power production freeing energy conversion from the, up to today, limiting Carnot efficiency.

On the other hand, fuel cells—being a 'non-established' technology—cannot draw from the 250-year history of steam, internal combustion motor and power station development, including all the improvements and optimisation exercises this history has brought about. The pending market entry of fuel cells is thus a struggle of a new and somewhat unproven technology to replace a well established, cost-effective adversary of long standing. This calls for a solid motivation of the market partners.

2. Starting point

Analysing the rationale behind industry and research efforts the most prominent characteristic of fuel cells as opposed to combustion technology is the superior efficiency and the near-to-nil pollutant emission. The bulk of road vehicles sold and operated today display an average tank to wheel energy conversion efficiency in real driving cycles of 12–15%, the average power station electrical efficiency in Germany is as low as 33% [1]. Fuel cells could improve these figures to something above 30% and 50%, respectively [2]. Roughly speaking, this is a factor of '2' and justifies the postulation of an 'efficiency leap' or change in 'technological paradigm'. Moreover, fuel cells operated on hydrogen merely emit water vapour as an exhaust gas which, not only environmentally speaking, is a very attractive prospect.

The low efficiency of today's technology, though, is not inevitable. To meet rising energy costs and regulatory issues conventional technology has over time dramatically improved efficiency and emission levels. Should a competitor, like fuel cells, enter the market, industry may well further exploit the margins towards advanced developments of internal combustion engines and power station technology thus narrowing the advantages fuel cells can offer. This 'sailing ship effect', first identified by Rosenberg [3] and Howell [4], has been seen in a number of industries, most notably the competition between sailing ships and their competitors the steam ships, and can be seen as a positive indicator that the incumbent technology views the new technology as a serious threat, increasing R& D efforts with the impact of breaking away from the traditional S-Curve of development. Fuel cells will thus face the problem of continually increasing requirements in the way of technical specifications of conventional alternatives, as these in par-

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allel and in competition will also be further improved (cf. for instance the EU vehicle emission regulations EURO5, in force from 2008).

In order to attain significance for the market, i.e. commercialisation, fuel cells need to meet the cost margins dominating propulsion, power generation and electricity supply today. Obviously, in the short term this will be impossible for fuel cells to attain. As with any other new technology, first niche markets have to be found, low numbered series sold, market introduction schemes (in this case most certainly government funded) established, field market experience gathered and finally improved manufacturing processes developed, which result in high production rates and low output costs. With fuel cells, this will mean a long road to go with projections ranging from the year 2010 to anything beyond 2020 [5,6].

The market entry problem is not inherent to fuel cells but affects them more severely than other technology. Due to costly materials and manufacturing processes initial costs are very high. Also, fuel cells in many areas currently only offer marginal extra performance for the end user—apart from the environmental benefits—since they merely 'replace' conventional equipment of the same function (producing heat and electricity) without opening up new fields of application or extra performance for the user (i.e. higher consumer value). If environmental issues constitute one of the mainstays of fuel cell advantages (and marketing background) it is essential that these be very clearly defined, well documented and proven. High efficiency and environmental benefits alone are not commonly regarded as buying incentives, although some customer awareness of environmental issues definitely exists [7]. The question is, whether consumers will buy into commodities on these two decision criteria alone (as many applications of fuel cells imply).

3. Cost projections vs. added value

The usual approach to the problem of market entry of fuel cells is to call for dramatic cost reductions. Cost targets have been set by the US American SECA programme [8] as well as by the European Commission [9]. These targets are removed from today's equipment prices by a factor of 10 or more. Nevertheless, technological development indicates that the goals may be met in the medium and long term.

Relying on cost reduction alone, though, may turn into an Achilles' heal of fuel cell market introduction, in case this reduction is slower than projected and financiers and manufacturers pull out of the limping development [10]. This phenomenon can be observed already with some companies. (Historic) Comparison with the market entry of other technologies and commodities shows that costs and economic competitiveness alone did, and do not, determine market development for new products. The 'added value' offered to consumers and end users is critically important and may in some cases, as will be shown, compensate for otherwise completely uneconomic performance. This lays a special importance on defining exactly what the 'added value' of fuel cells is and exploiting and maintaining this characteristic in market entry strategies.

The 'added value' for the end user or consumer is defined here as the value attributed to some property of a consumable or commodity that offers an end-user performance (or 'usefulness') above the average of comparable services, or products, and/or above the material value or common usage. It constitutes a price element that is generally 'soft', difficult to calculate (since it may vary individually) and subject to change. Nevertheless, product features that offer performance unobtainable with conventional equipment will spur the market introduction of a new product considerably.

4. Technological change and usefulness

In the past, various major changes in technologies have taken place that were driven by a wide range of differing forces. From a vast choice of examples the following have been chosen for a qualitative inspection of the role 'added value' played in their development (mostly considering European situations):

- transition from coal, biomass, wind and solar energy to petrol(eum) from the middle of the 19th century;
- introduction of mobile telephones in the 1990s;
- introduction of small scale photovoltaic appliances in the 1980s;
- establishment of 'green electricity' as a marketable commodity since 1998;
- introduction of unleaded petrol and double glazing of windows in the 1970s.

These examples highlight some of the driving forces behind technological change—at least as far as it is market driven—and give some indication of the success that can be accomplished, or the pitfalls encountered.

4.1. *Petroleum age: convenience and mobility*

The late 19th century saw the large-scale introduction of mineral oil derivatives as an energy carrier for stationary and later mobile and portable applications. This was a process that spread over more than half a century until the necessary infrastructures had been established, oil wells developed and exploitation technology been advanced towards cost effectiveness. World oil production rose from 70 thousand tons in 1860 to 21 million tons in 1900 [11]. The 'oil revolution' was due to the far superior energy storage density, the comparatively easy handling and the synergies offered in conjunction with the parallel development of automobiles. Speaking in strictly technical terms, oil products were predestined for mobile applications. In stationary applications they hardly display any technical advantages compared to solid or gaseous fuels and subsequently never played more than a marginal role in electricity generation.