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Liberalisation — challenges and opportunities for fuel cells

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1. Preface

New technological developments always have to face the problem that they are new. Being new means that such technologies have to enter into market segments that are usually already more or less served by traditional techniques. Therefore, initial market volumes are low and units are produced in only small quantities with relatively high associated costs. Low market volumes and high costs could lead new technologies into a ''vicious circle'' where they never manage to break through the threshold of economic viability and therefore never manage to acquire substantial market share.

Fortunately, technological developments and development of markets are not that deterministic. One escape route out of such a ''vicious circle'' is to develop a technology and its market stepwise. The development of photovoltaic cells may illustrate this stepwise approach. The first market for PV cells was their use to recharge batteries in many electric appliances. In serving this market, new efforts of improving the technology were made. Larger production facilities could be established that led to growing volumes and lower prices. In such, PV cells also became attractive for use in remote power supplies. This led to further growth in market volume offering prospects to integrate PV cells also in peak-load electricity production. Here market volumes may be achieved that allow for further scale effects and the eventual use of PV cells to supply electricity into general distribution grids.

Fuel cells have come a similar way with stepwise market penetration. From niche utilisation in space and in the military, fuel cells are now at the edge of entering the large commercial markets. And these markets are also in constant development. Besides the transport market, the other large commercial sector is the stationary supply of electricity and heat produced by fuel cells. And especially the electricity market is currently in the process of fundamental change; some call it turmoil. In the following is given a brief account of this change in the electricity industry under the title of ''Liberalisation''.

Liberalisation is the opening up of formerly closed monopoly markets to competitive forces. The introduction of direct competition between suppliers and freedom of choice for electricity customers is considered by many as a revolutionary step. For example, the long-serving chairman of the British Central Electricity Generating Board, Lord Marshall, was quoted as saying [1]:

> *This is the most complex social experiment that has ever been done.*

He might have overestimated the problems of his sector, but this view is shared by many in the industry. It is, therefore, more than likely that such fundamental changes of liberalisation in electricity markets also effect the prospects of a new technology on the edge of entering this market. What are the likely implications of liberalisation on energy equipment suppliers, in particular on fuel cell development? In order to try a sophisticated guess of what these implications might be, let us first give a brief overview of what liberalisation means.

2. Implementing the EU Electricity Directive

As of February 19, 1999 the majority of member states within the European Union (EU) have concurred to their legal obligation of implementing the Electricity Directive [2]. For most member states of the EU this is the basis of liberalising their electricity markets. This has not been achieved overnight. Endeavours to achieve competition in the electricity industry have been ongoing for some time now. As the founding fathers of the EU realised, a Euro-

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pean internal market open to competition could not accommodate any ''monopolistic exclaves''. What began with the signing of the Treaties of Rome in 1957 for almost all branches of the common European market also applies to the electricity industry: the EC Treaty Article 85 states:

> The following shall be prohibited as incompatible with the common market: all agreements between undertakings... which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion on competition within the common market...

As a result, there was an interim situation prevailing for 40 years, from 1957 until the European Electricity Directive came into force. Today, however, the breakthrough to competition on the electricity market has finally been achieved.

The effective completion of a liberalised internal market will, nevertheless, still keep the Commission, member states, electricity generators, grid operators, suppliers, traders and, not the least, electricity customers busy for a considerable time. This fundamental change of the market will also pose new demands on the energy equipment suppliers, including fuel cells. From the perspective of industrial electricity customers the Directive requires three essential steps of reform.

2.1. Unbundling

The first step relates to unbundling. The value-added processes which are open to competition must be separated out from functions which, of necessity, remain organised in the form of a monopoly. Otherwise discrimination, cross-subsidies and distortions of competition will be inevitable. Unbundling, according to the Directive, does not mean that vertically integrated companies have to divest entirely from certain activities in terms of capital. However, they are obliged to establish independent management for the transmission system (Electricity Directive Art. 7 para. 6) and to make sure that in the accounts transmission and distribution are separated from other activities (Electricity Directive Art. 14 para. 3).

We regret that the Directive does not explicitly require unbundling of electricity sales also, but categorises sales activities — or supply activities as it is called in Britain — alongside distribution. We can expect potential for conflict here, as unlike distribution, electricity sales or electricity marketing are certainly exposed to competition. This has recently become impossible to ignore, as electricity firms have launched broad new advertising campaigns.

Today, electricity consumers are allowed to change suppliers. This means that marketing, customer care and client acquisition is becoming an independent and important activity. We think that an electricity company which is open to competition should, in its own interest, keep this new market separate from all transmission and distribution functions. Otherwise, internal inefficiency and ongoing discrimination against new suppliers and their clients could easily develop.

However, even if distribution and sales are dealt with by different departments, contacts between the two may be very close. In its report of 19 February this year, the Commission quite rightly gave considerable weight to the statement that management unbundling and ensuring that confidential information is not passed on by the transmission system operator to other parts of the undertaking are essential conditions for guaranteeing fair access to the system to all players in the market.

We know from day-to-day practice that some reforms still lie ahead of us in this area. ''Chinese walls'' to impede the flow of sensitive information which might distort competition are an alien concept to many electricity companies.

2.2. Access to the network

The second step of liberalisation relates to access to the network. Whatever type of access the member state opts for, access to electricity networks must be possible for all competitors at the same conditions and prices, that is on an absolutely nondiscriminatory basis. Articles 17 and 18 form the core elements of the Electricity Directive. Most member states have chosen regulated access to the network; the current exceptions are Denmark and Germany, which have introduced negotiated access. Both alternatives are subject to the same high level of requirements and have to promote liberalisation of the electricity markets in a comparable way. We consider that only practice and comparison of experiences in the member states will show how both regulated and negotiated access to the system turn out.

The Directive does not go into much detail about access to the network. Yet the rules and prices for access of all customers to the system play a decisive role in the development of competition. In the electricity market customers can only buy from the supplier of their choice if they can use existing networks. The principle of equal treatment between independent suppliers and those of vertically integrated utilities must be applied to the letter here.

In our view as industrial consumers, the transmission and distribution services should be run as efficiently as possible. And even in areas where there is still a monopoly, incentives to enhance efficiency should be introduced. Therefore, the old principle of full coverage of all costs is no longer viable. Network prices will be subjected to national and international comparisons to a far greater extent. This will make it possible to establish benchmark prices that should be the yardstick for all grid operators.

Terms and prices of the grids will be exposed to national and international comparisons and international price leaders will set the standards for all. This in turn may provide a spur for improved performance. In Austria for example, in pursuit of this aim, it has been possible since 19 February 1999 to introduce ''productivity discounts'' on network prices. In the same way, the British electricity regulator has just suggested new distribution prices. If they are adopted, distribution prices will fall by 16% to 21% in 2000 and 2001. This should also encourage less efficient system operators in all of the EU to make greater efforts.

In order for network prices to be compared, they must first of all be public. Prices for use of the individual voltage levels are not the only important factor here. It is equally important to know the costs of system losses. Another important element is the balancing market, as prices demanded to compensate for divergences between agreed input into the system and what is actually taken out within each period of measurement.

Charges should not just be worked out on the basis of continuous use of the system over a whole year. Rather, there is a need for prices that allow the purchase of electricity for a few months, weeks and even hours. In a lively competitive market long-term purchase contracts should be complemented by contracts covering much shorter periods. Use of the system should be so economic and reliable as to facilitate standardised, anonymous and very short term trading at an electricity exchange. Such trading means that network charges should not depend on the geographical distance between supplier and purchaser, especially as transport of the electricity over the corresponding distance very rarely takes place. We are therefore convinced that these prices should be non transaction-based ''postage stamps''. Network prices should not be based on individual transactions but on total input of a generator and on total takeout of a customer in a specific period of time.

In order to create an European internal market, conditions for use of the system must allow electricity to be supplied throughout the EU. At the beginning of February 1999 the Energy Consultative Committee of the EU Commission considered a revolutionary idea. According to this, the transmission charges for cross-border electricity supplies would consist of the current national tariff for the generator feeding electricity into the system plus the tariff for the customer receiving the electricity. There would be no duplication if the total calculable system costs were split roughly fifty-fifty between the supplier and recipient. As a result the network costs of an electricity customer in Duisburg would not depend on whether he purchased electricity from Berlin, France, the Netherlands or Denmark. And in order to let genuine ''transit systems'' share in the profits, internal financial settlements should be set up between system operators. The fact that within the Energy Consultative Committee electricity suppliers and customers both agree on this proposal is an important success.

2.3. Market opening

The third step of liberalising electricity markets according to the Directive is market opening. This is also the main focus of public interest. The Directive obliges all member states to open their markets at least far enough to allow access to the market to customers above a certain threshold, which is itself being lowered. Most countries already went beyond the minimum requirements when taking the first step. In particular, Sweden, Finland and the UK are praiseworthy pioneers in this field. In Germany also all customers are ''eligible'' to choose suppliers.

According to the Commission's report of 19 February, two-thirds of all electricity consumers in the EU are now legally able to choose their electricity supplier freely. This bald statement is of course rather deceptive. Given the unresolved questions of unbundling and access to the system, it is not surprising that so far, outside the UK and Scandinavia, only a few customers have made use of their right to choose or change their supplier. Many of the obstacles, risks and costs are simply too high. Market shares have not shifted noticeably. Only very recently have we seen a new movement, which leads us to expect considerable changes in market structures.

The applications made by most member states for derogations and transitional arrangements will unfortunately occupy us for quite a while yet. In Germany, for example, access to the system — and hence, of course, market opening as well — can still be restricted until the end of 2003, if this means that the use of East German lignite is safeguarded in certain cases. Further restrictions can be imposed if opening up the system would jeopardise the use of efficient and environmentally friendly combined heat and power plants. France, on the other hand, plans to allow market access only for those competitors that guarantee the same social standards as traditional suppliers. This could imply, for instance, the same working hours per week for employees. Or, only such suppliers are granted market access that also generate electricity themselves. This would be a barrier against all electricity traders and would also block an anonymous energy exchange. We think that these would be unacceptable impediments to competition and would not be compatible with a free market. After all, what we really need are new ideas and competition from all players on the market, including the independent electricity traders!

This handful of examples should suffice to show that for the moment at least, the electricity markets in member states are still liberalised to different extents. As a result, electricity undertakings in countries with wide open markets are subject to increased pressure of competition, without being offered similar market opportunities in more restrictive neighbour countries. The reciprocity clause will do little to remedy this imbalance. It can be circumvented: just think of the growing trade in electricity where it is getting harder and harder to prove the country of origin.

We will therefore do all we can to support the Commission in its efforts to ensure equal opening of markets throughout the EU.

3. New pressure on electricity prices

From a customer's perspective, the major success of liberalisation so far is the growing pressure on electricity prices. Therefore, for fuel cells also, economic viability is a moving target and benchmarks to become competitive are increasingly challenging.

Already before implementation of the Electricity Directive, the average electricity price for industrial customers throughout the EU has fallen by 6% from 1997–1999. For industrial customers with demand between 2 million kW h (0.5 MW/4000 h) and 70 million kW h (10 MW/7000 h) it now figures at 5.33 Euro cent/kW h. The most expensive locations are Italy, Germany (7.07 Euro cent/kW h) and Austria, whereas in the UK medium prices and in Sweden and Norway best prices are available. This figure is based on data of the statistical office of the EU, Eurostat. In a liberalised market it is less and less viable because it only covers a handful of locations and only standard contracts for medium-sized customers.

A price indicator for the German market is published by our association VIK together with Dow Jones Newswire. According to this Dow Jones/VIK Index average electricity prices for industrial customers have fallen by 12% only within the first year of liberalisation. From April 1998 to July 1999 all monitored standard contracts of about 50 German suppliers have seen falling prices; the August price is 6.92 Euro cent/kW h. This is still a very broad figure of many different customer cases. Contracts range from 0.16 million kW h (100 kW/1600 h) to 175 million kW h (25 MW/7000 h), and the main disadvantage is that these are all standard prices offered by utilities, not actually prices paid by customers.

We certainly know that these offers are where negotiations start today. In a liberalised energy market customers have room to reach much better deals. Prices that are the results of new contract negotiations are confidential. But, fortunately we now have other transparent prices that are increasingly used as yardsticks in a competitive market. These are electricity spot market prices. The most successful electricity spot market is certainly Nord Pool in Olso. Here suppliers, traders and customers from Norway, Sweden, Finland, Denmark, Germany and the UK trade electricity for delivery during the hours of the following day. Such short-term prices for megawatt hours are very volatile but the average price levels are also very attractive. During the course of this year the peak daily average price so far was traded on Friday, January 29 with 21.62 Euro/MW h; the lowest price of this year was 6.09 Euro/MW h on July 25, a Sunday. These are wholesale prices that do not include use of the electricity grids and neither include all supply services. You see that between winter peak and summer low there are margins of about 350%. Within a day, hourly prices may very well fluctuate by around 30%. Most electricity customers are not at all familiar with such high price volatility.

Other electricity spot market prices are quoted by the Swiss Electricity Price Index (SWEP), by the Central European Price Index (CEPI) and by the Amsterdam Power Exchange (APX).

4. Price volatility as an opportunity for on-site generation

To purchase electricity on a spot market is a new challenge for most industrial energy customers. Firstly, such price volatility was unknown in the stable and very risk adverse environment of monopoly franchises. In the past, electricity prices were negotiated for a period of 2 to 5 years. Traditionally, prices were adapted according to changing coal or labour costs but remained rather stable. Spot market price levels, on the other hand, are now very attractive but they also contain a certain risk of high fluctuations.

Secondly, purchasing on a spot market means that purchased volumes have to be paid for. In the past, to a certain degree, electric energy was only purchased on the basis of actual demand. With the exemption of certain minimum purchasing obligation, the bill was based on the volume consumed by the customer. The bill from the spot market on the other hand will be based on the volume a customer purchased at least 1 day before his actual demand occurs. Therefore, energy management systems that give clear indications of expected demand and that are able to regulate demand are becoming much more important for customers that buy on the spot market.

And thirdly, a bid on the spot market is never certain to be fulfilled. If a customer is bidding below the market clearing price he might not be served at all. Therefore, customers participating at the spot market always need to have a second option. Such an option could be an alternative supplier. It could also be available on-site generation.

On-site generation, based on fuel cells, might constitute an opportunity to counter all these risks mentioned. On-site generation may counter the risk of high price volatility, as, in periods of peak prices, electricity customers could switch to on-site generation. This needs technologies that are able to supply electricity in very specific periods on short notice. As fuel cells can achieve high loads within very short start-up times they could be very attractive to substitute for expensive electricity purchases in the market.

On-site generation, secondly, offers opportunities to match energy consumption and energy supply within each time period much more accurately. It therefore supports energy management systems very effectively. And thirdly, on-site generation could fill the gap in case a customer is,

during a certain period, not served by the spot market at all.

5. New flexibility of contract terms

Within a liberalised market we also see increasing flexibility with regard to other terms of energy contracts. The traditional obligation for customers to purchase all electricity demand only from one supplier is not accepted by customers any more. Already, in the past, we considered such a clause as a violation of competition rules, but it was rather an academic debate then. Today, customers are in a position to sign contracts with different suppliers for the same plant. Why should a specific supplier not offer very attractive terms in periods of peak hours whereas another supplier is more favourable during base load periods? This new flexibility of suppliers also offers prospects for on-site generation.

Presently, electricity customers no longer sign contracts any more that would prohibit them from selling electricity themselves. In the past, the prohibition of selling to further customers was regularly contained in electricity supply contracts. Now, customers do have the freedom to decide whether use of their own electricity is more favourable than selling it via a direct line to neighbouring plants or even to supply electricity into the grid. Such electricity-selling activities are also supported by available on-site generation capacities.

Therefore, in a liberalised market, on-site generation can be organised much more efficiently. Through the use of direct lines and through access to general distribution grids, on-site generators are not confined any more to one single location. With access to the grids they are able to supply further customers. For companies with many industrial sites, these customers might be other sites of the company. Customers might also be found among other industries, or among commercial companies or other utilities. On-site generators are therefore enabled to optimise their facilities regarding capacity and load factor. In the past, monopoly days on-site generators were only able to sell surplus electricity to the local utility. The price of this was regularly based on avoided costs of the utility. In a liberalised market, on-site generators may sell surplus electricity to their customers at a price equal to their avoided costs, which should be substantially higher. Such flexibility is only possible as energy market liberalisation opens access to the general electricity distribution and transmission grids.

Liberalisation also offers new flexibility regarding the purchase of reserve capacity. In the past, for on-site generators, the only supplier of reserve capacity was the local utility. As they were under no competitive pressure, their price for reserve capacity was relatively high. Today, reserve capacity can also be bought on the market and offers from various suppliers are available. In the future, it might be possible to totally do without any reserve contracts, because, as electricity spot markets develop, short-term purchasing will become available which could offer a very flexible and cost-efficient solution to any traditional contracts for reserve. This should also enhance the economic viability of on-site generation.

These are all opportunities that are available for on-site generators within a liberalised market. We, as the association of industrial energy customers and self-producers of electricity, are, therefore, convinced that on-site generation will prosper within a liberalised market. And the experience of markets that have become pioneers of energy liberalisation support this view. Whether fuel cells are the appropriate technology to realise these prospects is too early to judge. Delegates have much more expertise to value the prospects of this technology within a liberalised energy market. But as a conclusion let us give some notice of how German utilities are starting to promote fuel cell technology today.

6. Fuel cell projects by German utilities

Low emissions and high energy-conversion factors make fuel cells increasingly attractive for many German energy utilities. But their specific investment costs are still considered out of the range of traditional electricity generation technologies. Also, their limited lifetime is considered a serious barrier. Therefore, most demonstration projects that are in operation today focus on gaining experience with long-term operation and to acquire knowledge of how to reduce costs of fuel cell technology.

In spring 1999, four German utilities had already concluded their fuel-cell demonstration projects. Of these, three were local and one was a regional utility. Three used a phosphoric acid fuel cell (PAFC) and one a solid oxide fuel cell (SOFC). Many more projects are still under way. About 19 fuel cell projects are in operation or have been announced now. Most utilities rely on the technology of PAFCs. But two utilities now operate polymer electrolyte membrane fuel cells (PEMFC), one utility uses a molten carbonate fuel cell (MCFC), and most recently four utilities started — or will start — projects based on the solid oxide fuel cell (SOFC). Among the most recent projects are two very prominent German utilities.

In June, Energie Baden-Würtemberg together with Electricite de France, Gaz de France, Tiroler Wasserkraftwerke, and Siemens/Westinghouse announced that they will build the largest fuel-cell hybrid demonstration plant yet. In California, a plant based on SOFC technology and a micro gas-turbine will achieve a capacity of 1 MW. An electric utilisation rate of 60% is expected.

In July, the market leader by size, RWE Energie, announced that, together with Siemens/Westinghouse a 300-kW SOFC will be built in Northrhein-Westphalia. This fuel cell will be combined with a small gas turbine to

generate electricity and heat and will achieve an energy utilisation factor of 80–90%. The participants expect that within the next 10 years this technology will become commercially fully competitive with traditional generating stations. Its main market will be to supply electricity and heat to medium-sized industrial plants as well as to commercial and public sites.

These are certainly projects of high market value. In the liberalised market, utilities want to present themselves as supportive of promising new technologies and as environmentally proactive. At the same time, utilities today have to be prepared for new customer demands. As competitive pressure is also coming from on-site generation, the utilities themselves have to offer such technologies, and the experience in operating such technologies. Fuel cells are regarded as an important technology that will add to their competitive edge in the newly liberalised energy markets.

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