Proton Power Systems

September 2007

Index: **Aim**

Sector: **Renewable Energy**

Key points

- Leading hydrogen fuel cell hybrid drive system
- Focus on back-to-base vehicle markets
- Partnerships with leading global OEMs
- New, larger site for move to volume production
- Near term fair value seen at 73p / share

Proton Power Systems

Company Description: Proton Power Systems is the parent company of Proton Motor Fuel Cell GmbH, a leading independent fuel cell system developer based in Germany. Proton has developed a proprietary hybrid electric fuel cell system including energy storage and electronic energy management systems.

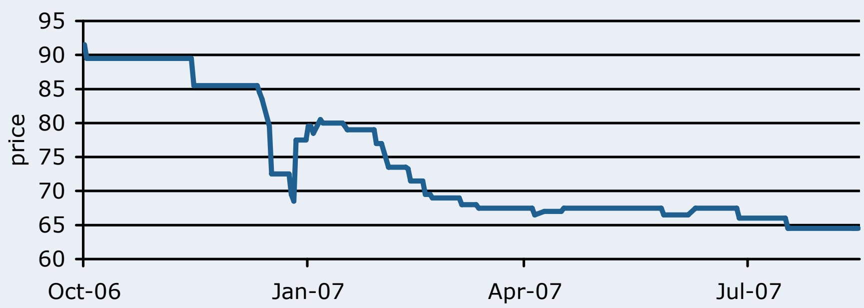
Proton Power Systems, through its subsidiary Proton Motor Fuel Cell, has developed and produced a proprietary hybrid fuel cell system, which additionally incorporates energy storage technology to provide power during peak demand situations. Hydrogen fuel cell technology is widely seen as the clean alternative to conventional heat engine – no harmful emissions - and conventional battery power - they do not require recharging, have longer operational cycles (limited only by hydrogen fuel tank capacity) and are not susceptible to decreases in power over the length of that cycle - in a wide range of transport and industrial applications.

Proton's fuel cell systems are field proven since 1999, with approximately 100 units built and tested so far in applications such as fork lift trucks and buses – two fuel cell markets forecast to grow significantly. Proton has established partnerships with leading global OEM's, including Linde, Volvo, VW, Skoda & Ecopower. The initial design of Proton fuel cell systems encompasses 41 patents (further 32 pending) and with 12 years of development no further technology innovation is required. Additionally, the Proton Motor Hybrid Electric Fuel Cell system is patented technology incorporating an energy storage system that improves the efficiency of the fuel cell system, giving it a distinct advantage over competitors.

Results for the six months to 30 June 2007 are in line with expectations, and in that period Proton received new orders for its hybrid power drive system for a passenger ferry in Hamburg, a utility vehicle in Switzerland and a Prague city bus for Skoda Electric. Proton Motor relocated its facility to a larger single-site in Puchheim, Munich, which will allow ready expansion to high volume production.

Proton, through its partnerships and demonstrated technology, is very well positioned to gain a leadership position in the emerging hydrogen economy, particularly in the back-to-base fork lift truck and city bus markets. This is still a nascent market, and like its fuel cell peer group, Proton is not expected to be profitable until 2009. However, comparisons with companies in the same markets leads to our near term target of 73p per share, and 125p in the medium term.

Figure 1: Price Performance



ADVFN

Proton Power Systems

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Date:		**19.09.07**
Price p (prior close)		**63.5**
52 week High/Low p		93.5/64.5
Issued share cap		**31**
Market cap £m		19.68
Year to December		**Pre-tax £m**
2006		-1,800
2007 E		-2,000
2008 E		-1,302
Year to December	**Earnings p**	**PER**
2006	-6.8	n/a
2007 E	-6.4	n/a
2008 E	-4.1	n/a

Proton Power Systems is quoted on AIM and investors should be aware that shares traded on AIM are subject to lighter due diligence than shares quoted on the main market and are therefore more likely to carry a higher degree of risk than main market companies.

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INTRODUCTION

Proton Power Systems, through its subsidiary Proton Motor Fuel Cell GmbH, has developed and produced a standard fuel cell module, fuelled by hydrogen integrated with an energy storage system to create a hybrid electric fuel cell system capable of providing power during peak demand situations. The market focus is on industrial applications where 'back-to-base' refueling occurs, on site, at the end of each shift or work period.

Proton has identified opportunities to replace batteries with their PEM fuel cell systems and has identified niche markets in the materials handling and mass-transportation sectors where hybrid electric fuel cell systems offer considerable advantages over conventional engine technology and fuel cell only drive systems. Proton has identified two initial market segments in which the Directors believe the advantages of hybrid electric fuel cell systems will lead to economic benefits for the end user – forklift trucks and buses. In most cases, these vehicles operate within a defined radius or return to central points of operation.

The many advantages over current commercial alternatives include lower fuel consumption, longer periods between refueling, shorter refueling, consistent levels of power delivery and zero harmful emissions.

Proton Motor's technology development has been undertaken with the key objectives of multiple applications and volume production.

Proton Power Systems was admitted to trading on AIM on October 31, 2006.

BACKGROUND

Proton Power Systems' subsidiary, Proton Motor, evolved from initial development work commenced within Magnet-Motor GmbH between 1994 and 1998. Acquired in April 2006 by L-3 Communications, Magnet-Motor is based in Starnberg, Germany, and is a leading developer and manufacturer of advanced electric and energy systems for propulsion. These systems are developed for tracked and wheeled combat vehicles, commercial buses and marine vessels.

Magnet-Motor had identified that fuel cell systems could be utilised as a critical element within electrical drive systems. During this time, Proton's proprietary Gas Diffusion Layer (GDL) was developed, along with a robust sealing technology, and the core material for use in the production of fuel cells was identified. Initially, Proton's technology was designed for industrial transportation and stationary off-grid applications and, as a result, the need for durability and robustness was a fundamental requirement.

Magnet Motor determined that further progress would be accelerated within a separately identified, independently managed company which was solely focussed on the commercial development of fuel cell technology and related drive systems. In 1998, all fuel cell related IP was spun out of Magnet Motor into Proton Motor Fuel Cell GmbH.

Since 2000, Proton has secured external funding from Volvo Technology Transfer AB and other German institutional and private investors. These funds facilitated the undertaking of several pilot projects and, to date, over 100 fuel cell modules for approximately 30 fuel cell systems have been built, tested and/or commissioned. During early 2006, Proton's ongoing commercial operations required further capital and Proton Power Systems was formed in February 2006 as a vehicle to facilitate interim funding. The company subsequently acquired Proton in a share for share exchange in April and May 2006. These new funds have enabled Proton to secure a number of project-based orders which require it to develop, manufacture and install hybrid electric fuel cell systems as a precursor to volume manufacturing.

Over the history of the company, a number of significant technical co-operation and product evaluation partnerships have been formed, including Gore Associates (a global developer and manufacturer of technical membranes), with an activity in the field of high performance PEMs, and SGL Technologies, which develops and commercialises carbon-based products for PEM fuel cells, bi-polar plates, foils and GDLs.

Prior to the AIM listing there were two significant sales. Firstly, in September 2005, Proton received an order from Linde AG, one of the world's leading manufacturers of materials handling equipment and one of the largest hydrogen suppliers worldwide, for 4 fuel cell systems for delivery during Q4 2006 and Q1 2007, and a letter of intent for a future order of up to 15 fuel cell systems.

In February 2006, Proton entered into a licensing and joint development agreement with L-3 Communications, the military applications developer, under which Proton issued a world-wide licence for the use of its fuel cell system in military applications.

Proton received an initial payment of €400k, with a further payment of €300k received subsequently, with the balance of €200k being due in Q2 2008. Regarding joint development, Proton has agreed to co-develop a fuel cell system specifically for use with select military applications in return for a total fee of €2.5m, to be paid over a period of 4 years.

Proton is engaged in a number of development projects from various OEMs which are expected to generate around €5.4million. This comprises:

- The remaining payments arising from the L-3 Communications agreement (as referred to above);
- A contract with the Bavarian State Government;
- A fuel cell bus with Skoda Electric in to operate in Prague;
- A street cleaning vehicle with Bucher in Switzerland;
- A number of public contracts.

In addition, the Group is currently pursuing over 20 serious commercial enquiries for the application of its fuel cell systems. Proton is also a party to a joint development contract to develop a zero emissions passenger ferry in Hamburg through a consortium.

In addition to its ongoing projects with Linde and L-3 Communications, the Group has had a number of other key OEM relationships at varying stages in the sales cycle, including:

- The supply of a hybrid electric fuel cell system to Volvo Bus Corporation is currently under development following the initial 150kW bus project for Volvo during 2004;
- A joint development project with Eco Power Technology S.r.l., an Italian bus manufacturer, for the design and commissioning of a hybrid electric fuel cell powered bus;
- A fuel cell battery recharging unit was commissioned by a third party electric bus manufacturer in September 2005;
- A non-operational, demonstration UPS electric fuel cell system was designed and built in March 2006 for Rittal GmbH & Co. Rittal is a leading global supplier of IT enclosure and housing technologies;
- A co-operation project for a UPS electric fuel cell system is under development with AEG Power Supply Systems GmbH / Saft Group. AEG is a world leader in the provision of power for industrial and telecom applications.

The company originally ran its operations in Starnberg, near Munich in Germany in a manufacturing and assembly facility that could support the production of 2,400 fuel cells per annum (or the equivalent of approximately 60 10kW fuel cell modules per annum). In July 2007, Proton Motor announced its relocation to a new facility in Puchheim, also near Munich. This site can accommodate around 100 staff, and houses the company's administration, research, development, production and test departments, with further potential for expansion as required. The move is expected to enable Proton Motor to scale business and enter into volume and automated production, and will provide an important platform for increased marketing of its fuel cell technology.

This is a significant step in the transition of the company from a low volume / high cost - to series – high volume / low cost / high value added designer, developer and manufacturer of fuel cell hybrid systems for the back-to-base applications market.

The new facility, officially opened on 13 September 2007, has been customised in line with Proton Motor’s specific requirements and currently covers an area of 3,000 square meters. With scope for extending the building by another 2,000 square meters, the site could provide space for around 200 staff in the future. The leasing agreement is designed so that any extension, which has approval already in place, can be built quickly allowing the company to expand its capacity at short notice in response to growing market demands.

Milestones

1994 Magnet Motor begins fuel cell development

1998 Proton, under Dr. Götz Heidelberg, leaves the umbrella of Magnet Motor.

1999 Proton equips a working vehicle with a fuel cell for the first time.

2000 Proton presented their first fuel cell hybrid bus, and Volvo invested in Proton.

2002 Partnership with Volvo produces Proton’s first 150 kW fuel cell bus system. Proton awarded Bavarian Energy Award for the ongoing work in an innovative field.

2004 Fuel Cell Fork Lift Truck handed over to Munich airport, operating in the cargo area.

2004 Proton delivers a fuel cell power generation system for the National Research Council of Italy.

2004 Proton delivers a hybrid fuel cell system for a minibus for SGL Technologies

2005 Proton supplies fuel cell systems for a small fleet of material handling vehicles

2006 Proton enters into agreements with military applications developer L-3 Communications, for licensing and development contracts valued at €3.4million.

2007 Proton begins work on hydrogen fuel cell-powered ship, a fuel cell hybrid system for a city bus with Skoda, a street cleaning vehicle with Swiss Bucher, using its existing product line. Proton moves to a larger site within Munich.

INTERIM RESULTS

The results for the six months to 30 June 2007 were in line with expectations, with revenues (excluding the £576,000 licence fee income from L3 Communications Corporation in the same period last year) more than doubling from £142,000 to £295,000. Again, adjusting the net loss in the same period last year for the licence fee income, the corresponding figures are a loss of £1,053,000 in 1H 2006 and a loss of £ 951,000 in 1H 2007. Orders are reported generally in line with expectations, with new orders received for Proton hybrid drive systems for a Hamburg passenger ferry project, a street-cleaning vehicle (Switzerland) and a city bus for Skoda Electric which will operate in Prague.

Table 1: Income statement

6 months to 30 June	**2006A**	**2007A**
£ 000s		
Sales	718	295
Cost of sales	-680	-423
Gross profit	**38**	**-128**
Gross margin	5.3%	
Other operating income		25
Administrative expenses	-501	-882
Operating profit	-463	-985
Finance income		50
Finance costs	-14	-16
Pre-tax profit	-477	-951
Tax		
Net profit	-477	-951
EPS basic, p	**-1.9**	**-3.0**
EPS diluted, p	-1.9	-3.0

Company

Closing cash and cash equivalents stood at £2.025 million (£1.886 million on 31 December 2006).

Achim Loecher was appointed Chief Financial Officer of Proton Motor Fuel Cell GmbH in June 2007.

TECHNOLOGY

The Hydrogen Economy

Population growth and the industrialisation of emerging economies are forecast to lead to a doubling of global energy demand by 2050. The supply of fossil fuels that have underpinned economic growth for the past two centuries is seen to be dwindling and security of supply is threatened. In addition, the chemical and particulate pollution associated with the burning of fossil fuels has given rise to health concerns and increasing restrictions, compounded by the global warming threat from the greenhouse gases emitted. Energy security, environmental quality, and global competitiveness in energy technology, for example, are moving the United States to investigating a hydrogen economy, with the Hydrogen Fuel Initiative addressing the need for hydrogen as a secure future energy source for the United States.

Hydrogen, an energy carrier, is seen as a promising alternative to fossil fuels, reacting explosively with oxygen in internal combustion engines, or silently in fuel cells in a process that generates electricity, with water as the only by-product. Whilst abundant in nature, hydrogen is found in chemical compounds like water or hydrocarbons, and thus must be produced in a process. Currently, most of the world's hydrogen is produced from natural gas by a process called steam reforming, a process that clearly uses the fossil fuels that are to be conserved, and moreover a process that emits carbon dioxide.

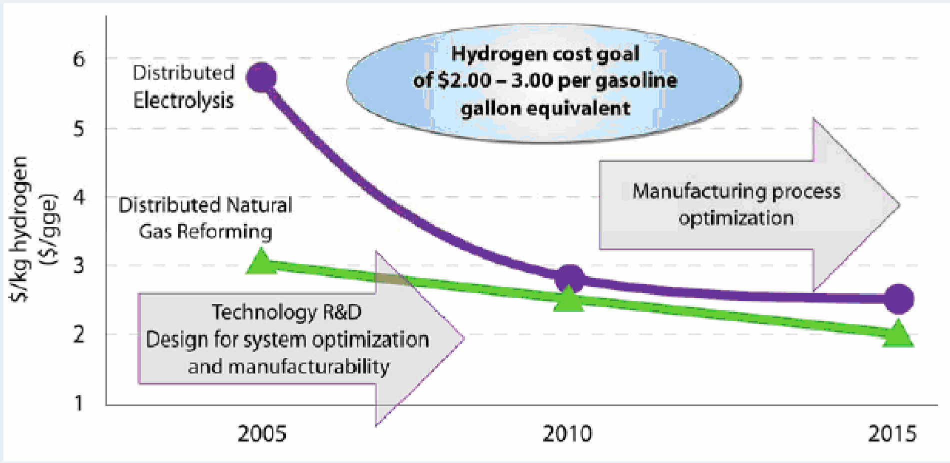
The US Department of Energy estimates that by 2040 cars and light trucks powered by fuel cells will require about 150 megatons per year of hydrogen. The US currently produces about 9 megatons per year, almost all of it by reforming natural gas. The challenge is to find inexpensive and efficient routes to create hydrogen in sufficient quantities from non−fossil natural resources.

At the moment the most promising route is splitting water by electrolysis. To eliminate fossil fuels from this cycle, the energy to split water must come from non−carbon sources, such as electricity generated from solar radiation and other renewable sources, and the heat from a nuclear reactor or solar collector.

Hydrogen is highly attractive as a fuel because of is its natural compatibility with fuel cells. The higher efficiency of fuel cells—currently 60% compared to 22% for petrol or 45% for diesel internal combustion engines—would dramatically improve the efficiency of future energy use. Coupling fuel cells to electric motors, which are more than 90% efficient, converts the chemical energy of hydrogen to mechanical work without heat as an intermediary.

The cost of hydrogen produced safely and efficiently from on-site hydrogen generators must be lowered enough to be competitive with petrol on a cost per mile driven basis, without adverse environmental impacts. Today the cost of high-volume hydrogen production and delivery stands at between two and three times the US Department of Energy (DOE) target of $2.00−$3.00/gge untaxed (gge is gasoline gallon equivalent on an energy basis). Fig below depicts the reductions in hydrogen production costs that need to be achieved for distributed steam methane reforming and electrolysis to be competitive with gasoline. These required reductions in the cost of producing hydrogen will require both technology and manufacturing R&D.

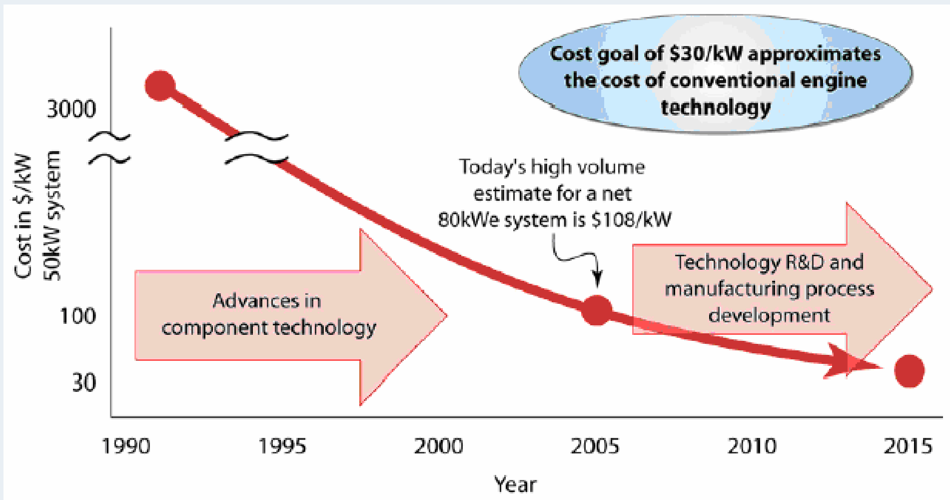
Figure 2: Cost goal for hydrogen



US DoE

In vehicle applications, PEM fuel cells are of interest because they have fast start capability; they operate at low temperatures, and have appropriate specific energy densities. The pathway to cost reduction of PEM fuel cells as seen by the DoE is illustrated in Fig . Today's estimate of the cost of fuel cells is based on advances already achieved in PEM fuel cell technologies coupled to assumptions of high-volume manufacturing. As depicted in the second arrow (to the right), further cost reduction will require technology R&D and development of new manufacturing processes.

Figure 3: Cost reduction for PEM fuel cells



US DoE

Fuel Cells background

Fuel cells are silent devices that generate electricity and heat electrochemically from fuel efficiently and cleanly, and with no moving parts. While similar to primary cells (batteries), fuel cells store their fuel externally. Typically they run off a fuel, for example hydrogen, and an oxidant, e.g. oxygen, and operate when the gases are supplied to them. An individual cell produces a voltage of around 0.7 volts (DC), and up to a few hundred watts of heat. Cells are generally assembled into stacks to provide larger voltages and power, and designing for reliable and efficient stacking is emerging as a key factor to commercialising the technology.

Although scientists were familiar with the principles of fuel cells since the nineteenth century, they first gained prominence in the manned spaceflight programmes of the 1960s. Alkaline fuel cells famously provided electricity and drinking water for the Apollo astronauts, for example.

Currently they are regarded as offering an important option for improving the sustainability of energy use and reducing GHG emission, and in portable consumer electronics the appropriate technology offers cost-effective replacements for batteries.

The major types of fuel cell are shown below.

Table 2: Main types of fuel cell

Type	Electrolyte	Operating Temp, C	Developmental status	Applications
Solid oxide fuel cells(SOFC)	Ceramic, solid oxide, Zirconia	700 - 1000	Tubular systems demo'd Planar systems trialling	CHP, power generation, transport
Intermediate temperature SOFC (IT-SOFC)	Ceramic, solid oxide cera-gadolinia	650 - 750	Fundamental research ongoing	CHP, power generation, transport
Molten carbonate fuel cell(MCFC)	Molten lithium carbonate	630 - 650	2MW and 250 kW demo'd	CHP, power generation, transport
Phosphoric acid fuel cell(PAFC)	Phosphoric acid	190 - 210	200 kW systems available	CHP, power generation
Alkaline fuel cell(AFC)	Potassium hydroxide	50 - 200	Long history in spaceflight	Space, transport
Solid polymer fuel cell(SPFC), also known as proton exchange membrane fuel cell (PEM)	Sulphonic acid incorporated into a solid polymer membrane	50 - 90	250 kW CHP systems Several cars and buses being demonstrated, not yet commercial	Commercial/ residential CHP, distributed power, portable power, uninterruptible power supplies, transport
Direct methanol fuel cell(DMFC)	Sulphonic acid incorporated into a solid polymer membrane or sulphuric acid solution	50 - 110	Still at R&D stage, fundamental research still needed	Portable power, possibly transport

ED

Of the range of fuel cell types, the proton exchange membrane (PEM) type has been prominent in the "hydrogen economy", and there are many examples under development in the automotive and transport sectors. At the other end of the size spectrum the direct methanol fuel cell (DMFC) is receiving a lot of attention among mobile phone and portable computer manufacturers.

In general, the low temperature fuel cells are better suited to battery replacement in mobile and portable applications, while the high temperature types are most appropriate for stationary power and CHP applications where rapid start-up and load-following are less of an issue. Importantly, the heat generated can be utilised in these applications.

PEM technology has been targeted at the automotive sector (e.g. Ballard).

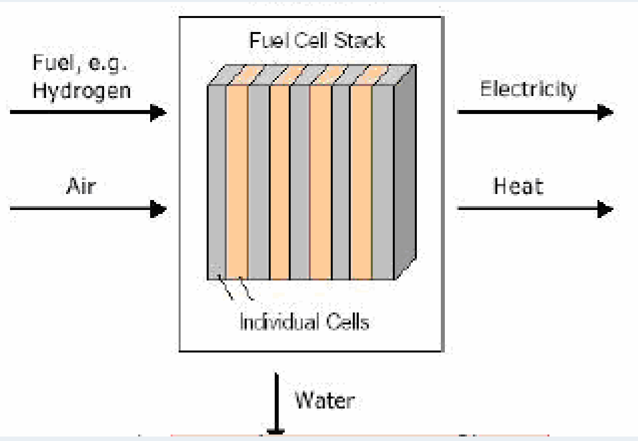
Proton's Technology

Fuel Cell Stack

The Proton fuel cells are designed to be stacked together in a modular fashion as shown below. By utilising a modular system, Proton allows the production of standard fuel cells, which can be combined into a scalable system in order to meet the power requirements of a particular end-user application. This maximises the potential to perform simple and cost effective volume manufacturing. Proton's standard 10kW fuel cell module is a combination of 40 fuel cells stacked together.

Hybrid Electric Fuel Cell System

Figure 4: Fuel Cell Unit



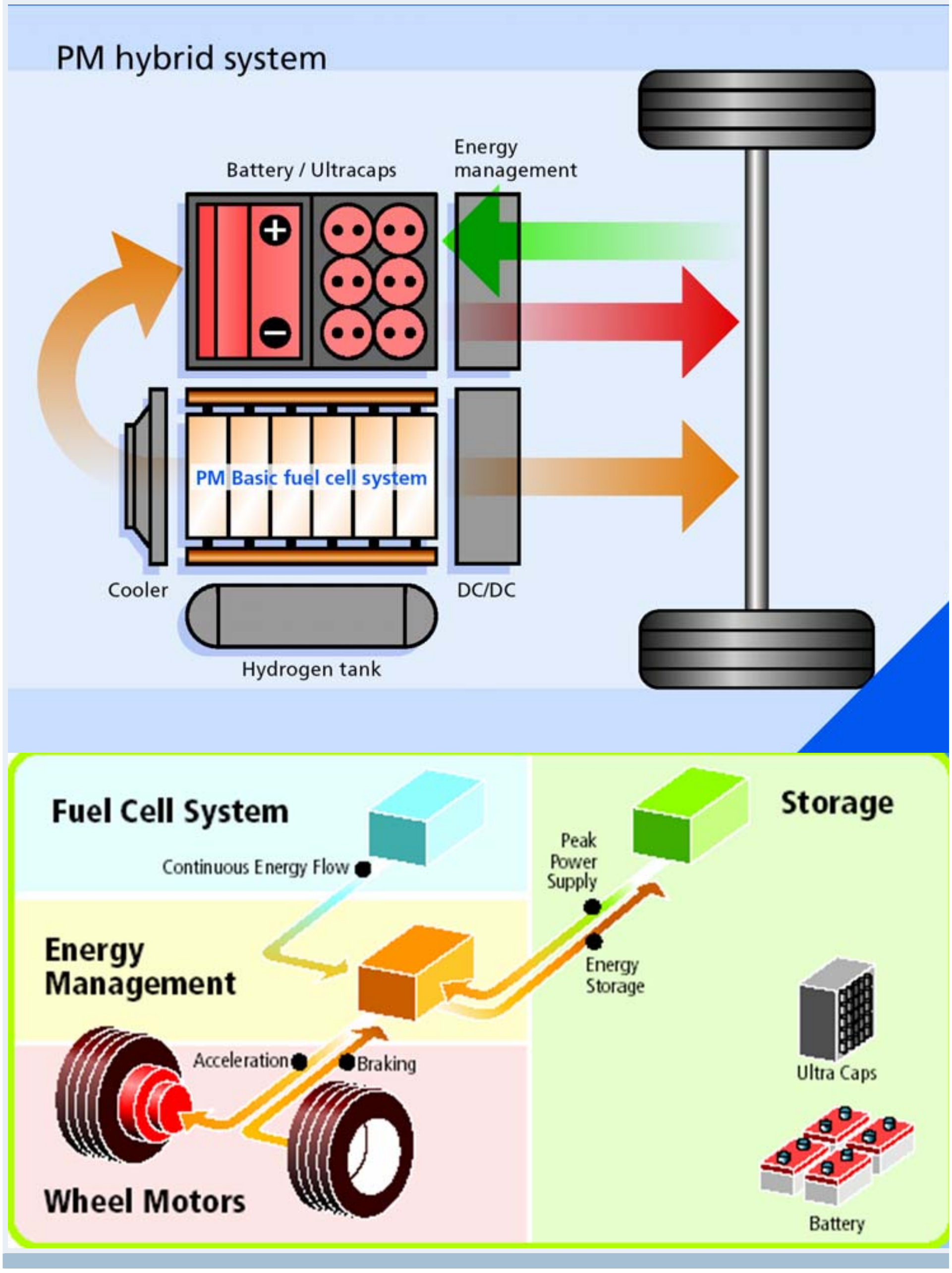
Company

The Hybrid electric fuel cell system is a complete drive system for use in vehicles such as forklifts and buses. The system is designed to maximise fuel efficiency over the operating cycle of the vehicle. It manages to achieve this by storing excess energy, which is generated during braking, and utilising that energy later at times of peak power demand, such as when the vehicle is accelerating.

This energy store-and-release system produced by the Proton hybrid system offers a number of advantages over systems powered only by fuel cells:

- Fuel consumption is more efficient
- Less fuel cell modules required
- System is smaller and more compact
- Hydrogen consumption reduced
- Hydrogen tank space can be reduced

Figure 5: Hybrid Electric Fuel Cell System



Company

The key features of the Hybrid Electric Fuel Cell System are:

- Fuel cells and "balance of plant"
- Energy storage system – Ultracapacitor, Batteries
- Energy management system
- Hydrogen tank and ancillary components

Fuel Cells and Balance of Plant

The main components of the fuel cells are:

- PEM and Catalytic layer - Designed in conjunction with Gore; supplied by Gore.
- Bi-polar plates - Designed by Proton; produced by selected 3rd parties.

- GDL and sealing system - Key proprietary, patented components; designed and produced in-house
- BoP - Primarily standard components; readily source from third party suppliers

Energy Storage System

The energy storage system is where the excess power generated through braking is stored until it is required to supply peak power demands. An extensive period of development took place before it was decided that the Energy Storage System should take the form of an ultracapacitor, flywheel and traditional batteries.

Ultracapitors work by storing electricity provided from an outside source, they are unable to store it for long periods of time, unlike batteries which use a chemical reaction to generate electricity. Ultracapitors work well in that they do not allow power spikes (during breaking) to pass through and they immediately begin to discharge once the supply of electricity is cut off.

They function by using two conductive plates separated by a dielectric. The dielectric is able to transmit an electric field, but not electric current. As a result, the current will flow through the capacitor while it is charging but not once it is charged. Therefore once the vehicle comes to a stop and subsequently the driver presses the accelerator during peak power demand the capacitor is able to produce power of up to 400 kW instantaneously (versus battery power of up to 50 kW) reducing the burden on the fuel cell stack.

During breaking, the vehicle loses a significant amount of energy particularly when slowing down from high speed. Proton utilise the electric motor not only to propel the vehicle, but to also act as a resistor, transmitting power to the ultracapacitor (up to 500,000 cycles). The resistance during breaking turns the motor in reverse to act as a generator.

The flywheel energy storage operates by accelerating a rotor to a very high speed and maintaining the energy in the system as inertial energy. Energy is stored by using an electric motor to increase the speed of the spinning flywheel. The system releases its energy by using the momentum of the flywheel to power the motor/generator.

Energy Management System

The Energy Management System was designed and specified by Proton to optimise the interaction between the various components of the hybrid electric fuel cell system. Although a third party manufactures the device, the software is written and installed in-house.

Proton has inherited a significant knowledge in electric drive trains from its parent Magnet-Motor. This has allowed Proton to reduce its commissioning and development time to market for its customers.

IP

Proton Motor has 50 patents granted and has a further 29 patent applications pending covering certain areas of their fuel cell system:

- Cell design;
- Stack design;
- System design and operation.

To further leverage the Proton brand, the company has applied for trademarks for the Proton Motor mark and logo and intend to require the company's future licensees to apply the logo to all promotional material and capital equipment. The patents are intended to cover a much wider range of solutions than are actually implemented in order to prevent competitors from circumventing the company's proprietary rights and to also increase the size and complexity of the barriers to market entry for potential competitors. Proton believes that the key areas of the technology required to implement its strategy are covered by granted patents, patent applications, trademarks and know-how.

Competitive advantages

Proton brings a range of attractive advantages to the power systems market:

- Zero harmful emissions
- Lower fuel consumption than comparable commercial alternatives
- No recharge required – just a quick refill
- Silent operation
- A standard fuel cell module for use in multiple applications
- A reliable, robust and durable technology – the PEM has been tested to operate for up to 20,000 hours.

STRATEGY

Proton aims, through its wholly owned subsidiary, Proton Motor, to become the highest quality and lowest attainable cost, designer, developer and producer of high volume, environmentally friendly, zero CO2 emission fuel cells and fuel cell hybrid systems to a wide range of customers in the niche "back to base" refuelling transportation and commercial and industrial stationary applications market sectors and to satisfy customer needs at a price/value relationship unmatched by competitors.

Proton's analysis of the market (to be discussed later in this report) has highlighted 2 market segments in which the advantages of the hybrid electric fuel cell system will yield economic benefits to the end-user: forklift trucks and buses. While Proton is working with leading European OEMs users in maritime, airship and street vehicle sectors, materials handling and buses represent areas with clients actively pursuing fuel cell systems.

Proton has established strong relationships with key OEMs in its target markets, and expects to expand this customer base as its volume manufacturing capability increases. Proton has identified the criteria defining attractive primary markets and applications:

- Early stage of development
- Need to reduce industrial emissions
- Potential material volume sales
- **"Back-to-base"** or stationary applications
- Existing power generation technology applications with notable disadvantages.

The sort of notable disadvantages inherent in current power generation includes the slow recharge time of battery technology as well as additional working capital infrastructure where continuous battery use is required, combustion engines emitting harmful emissions and noise pollution, and external electric power delivered by overhead cables with its geographical and logistical limitations.

Driving for volume applications, Proton has:

- Identified its target markets and commercial applications
- Established key commercial partnerships within these target markets
- Designed its fuel cell systems for manufacturability
- Established quality control procedures
- Reviewed, risk assessed and secured supplier and component manufacturing relationships
- Identified and assessed major commercial factors such as cost, availability, robustness and durability of components.

Proton is investing in Proton Motor's facilities and people to bring about a significant reduction in unit costs, improve competitiveness, achieve cost leadership and scale the business from what is essentially a project (low volume/high cost) to a series (high volume/low cost/high value added) designer, developer and producer of fuel cells and fuel cell hybrid systems. In addition to the new site Puchheim site, which is capable of modular expansion up to 21,500 units of 10kW modules per annum by 2012, Proton's investments include:

- acquisition, installation and commissioning of flexible and automated production and test facilities and dedicated tooling for certain purchased parts necessary to drive down unit costs
- acquisition and commissioning of forklift truck, bus and boat demonstrators to facilitate roll-out of the technology to as wide an audience as possible
- development and retention of existing, and recruitment of new, key team members
- acquisition and commissioning of research and development equipment and facilities to drive innovation and creativity and thereby generate increased intellectual property and patents and achieve increased product life and reduced cost of ownership
- develop upstream and downstream strategic alliances, joint ventures and identify possible selective acquisition targets
- Obtain accreditation to ISO 9001 and ISO 14001 Quality and Environmental Standards

Proton has adopted a strong partnership approach as a core element of its business strategy in the firm belief that volume sales will emerge through established relationships. It is a very reasonable assumption that selling any industrial product into a global market requires OEM partnerships with worldwide reach, and it can be expected that efficient and successful execution with the OEM partners will enable Proton to be recognised as a global, hybrid fuel cell technology platform.

FUEL CELLS VS BATTERIES

While there is broad usage of batteries in many classes of forklift truck, there is also a realisation that they have significant drawbacks in terms of the consequences of losing charge during the course of a shift, and their deterioration with age. Poor performance characteristics of battery systems have led to fleet operators moving internal combustion engines, but, with the increasing regulatory pressure to address indoor pollution problems, the likelihood of fuel cells replacing both internal combustion engines and batteries in the forklift sector and beyond is increasing.

In normal operation – comprising 3 shift operators - each electric forklift has 3 battery units and I battery charger associated with it. It takes on average between 15 and 30 minutes to change batteries, up to 8 hours to charge them, and up to 6 hours for them to cool down. Operating cycles are around 4 – 6 hours compared to 10 – 12 hours for fuel cells. Refills take around 2 minutes and each truck needs one fuel cell system. The fuel cell delivers constant power and performance while the battery suffers substantial degradation in performance over the course of one shift.

On a lifecycle basis, PEM fuel cells can be cost competitive with batteries, especially when used with continuously used forklift trucks running 2 – 3 shifts per day when batteries would require a number of changes per day. In the US, fuel cells currently attract a Federal tax credit of up to US$1,000/kW, and with the savings stemming from the operational and maintenance advantages of fuel cells, a viable economic case can readily be made for them.

Table 3: Lifecycle cost comparison of PEM fuel cell and battery powered forklifts

	3kW PEM fuel cell paired with integral NIMH battery for pallet trucks			8 kW PEM fuel cell paired with integral ultracapicitor for sit-down rider trucks		
US$	Battery powered (2 batteries/truck)	PEM fuel cell powered (no incentives)	PEM fuel cell powered (with incentive)	Battery powered (2 batteries/truck)	PEM fuel cell powered (no incentives)	PEM fuel cell powered (with incentive)
NPV capital costs	17,654	23,835	21,004	43,271	63,988	56,440
NPV of O&M costs (inc Fuel)	127,539	52,241	52,241	76,135	65,344	65,344
NPV of total costs of system	145,193	76,076	73,245	119,406	129,332	121,784

Battelle Memorial Institute

Indoor facilities including factories and warehouses, operating on a multi-shift basis gain from the emission free and high performance benefits of fuel cells. The compelling value proposition for hydrogen fuel cell powered forklifts includes:

Increased productivity

- Reduced time spent in battery recharge or swapping
- Peak performance maintained throughout shift with consistent voltage output

- Fast refueling (approximately two minutes)

Improved Health and Safety

- Reduced injuries due to elimination of battery swapping process
- No harmful emissions and quiet operation

Reduced Maintenance

- Eliminate battery and associated equipment maintenance (battery watering)

Seamless Integration

- Fuel Cell Power Packs seamlessly integrate into existing battery compartment of electric material handling vehicles

Reduced Infrastructure

- Eliminate the need for multiple battery packs per truck, a battery recharger per truck, battery swapping equipment, battery charging station space, and battery swapping personnel.

MARKETS

As discussed above, Proton sees the forklift truck and buses markets being the immediate focus, there exist a number of additional markets which the company has begun to address, including:

- Other material handling applications (outside the forklift trucks market);
- Auxiliary power units, APUs, for applications such as lorries (providing electricity generation and power when the motor is not in operation);
- Uninterruptible power supplies, UPSs, for applications within telecommunications, industry and public facilities;
- Leisure boats and ferries;
- Military applications;
- Local delivery vans and street vehicles.

The primary and secondary markets also can be targeted effectively via the industrial battery market, with standardised fuel cell products being sold as replacements for industrial battery systems. The total market for automotive lead acid based battery products in 2003 was estimated at approximately US$1.5 billion and for stationary applications at approximately US$2.0 billion.

Several manufacturers are testing forklifts powered by a combination of fuel cells and batteries, generally finding that these hybrids perform far better than the lead-acid battery systems now typically used. In some situations it is estimated that they could pay for themselves within two or three years.

This follows considerable efforts by automobile manufacturers and fuel cell companies like Ballard to develop hydrogen fuel cells that could power clean, electric vehicles, cutting emissions and decreasing dependence on oil. However, the experience to date is that manufacturing fuel cells big enough to power a car is prohibitively expensive, and their commercialisation is not now expected until 2015 onwards in automobiles.

However, by relying on batteries or ultracapacitors to deliver peak power loads, such as for acceleration, fuel cells can be sized as much as four times smaller, slashing manufacturing costs and helping to bring fuel cell-powered vehicles to market.

The forklift hybrids use ultracapacitors, devices similar to batteries but able to deliver higher bursts of power. The fuel cell powers the forklift as it drives through a warehouse, while at the same time the cell charges the ultracapacitors, which deliver energy when the forklift lifts a pallet.

Batteries and ultracapacitors could provide at least some of the accelerating power for automobiles in the future, allowing the fuel cell to be smaller.

In addition to supplying peak power, ultracapacitors and batteries give fuel-cell vehicles the ability to recapture energy from braking, as happens now with commercial petrol-battery hybrid vehicles. This can make the system much more efficient, especially in applications such as city driving. A vehicle powered by a fuel cell alone would not have this ability.

While hybrid systems could help make fuel-cell vehicles more affordable, other obstacles need to be overcome before these vehicles take over the roads. Fuel cells can run only as long as hydrogen is available, and that will require better ways of storing hydrogen in the vehicle and distributing it. Back-to-base operations, like forklift trucks and buses (and airport and street vehicles) clearly eliminate most of the hydrogen issues, particularly if hydrogen is generated on site.

Consequently, there has been a good deal of activity in the forklift area:

Table 4: Forklift trucks - main players and sectors, July 2007

Company	Area	Tie-ups	Ownership
Plug Power	Class 1 and Class 3	Ballard (stacks)	Listed
Hydrogenics	Class 1	LiftOne	Listed
Nuvera	Various	East Penn Mfrng	Private
Proton Motor	Class 1	Still	Listed
Toyota Motor/ Toyotal Industries	Class 1		Listed

fuelcelltoday.com

Plug Power recently acquired Canadian company Cellex and General Hydrogen , who have specifically targeted the forklift market. Hydrogenics are also heavily involved. At Hannover, Julich unveiled their latest product, a forklift based on DMFC technology.

Another early market is that based on chlor-alkali production, using industrial by-product as a source of hydrogen.

Hydrogenics is actively engaged in the development, commercialization, marketing and distribution of HyPX Fuel Cell Power Packs (FCPPs) for the material handling market through material handling OEMs and direct to end-users. Hydrogenics' hydrogen-fuelled HyPX replaces the batteries and associated recharging infrastructure used with electric forklift trucks. A HyPX consists of all the components necessary to replace a forklift battery pack including a Hydrogenics HyPM Fuel Cell Power Module, hydrogen storage, ultra capacitors, power electronics, controls and thermal management. Hydrogenics' hydrogen powered HyPX FCPP has been proven through real world deployments at GM of Canada's Car Assembly plant and FedEx's logistics hub at the Pearson International Airport, where fuel cell powered forklifts were used in day to day operations.

In addition, Nissan is currently trialling forklifts powered by hydrogen fuel cells for use at its assembly plant in Smyrna, Tennessee. Nine fuel cell forklifts are involved in the five-month trial being conducted by the car manufacturer. The fuel cells, supplied by a Canadian company, are being considered as a replacement for the lead-acid batteries currently used in Nissan's forklifts, and are seen as a way of reducing the environmental impact of the company's business activities. Nissan began its own development of fuel cell vehicle (FCV) technology in 2001. Its Industrial Machinery Division, based in Japan, is now considering potential applications of the technology in forklifts.

Forklift Industry

In 2003, batteries for use in battery powered mobile manufacturing, warehousing and other ground handling equipment, primarily electric industrial forklift trucks generated more than US$1.5 billion in worldwide sales. In 2004, the global market for sales of material handling vehicles was in excess of approximately 700,000 units and it is anticipated that battery powered forklifts' share of the material handling market will steadily increase.

Forklift trucks fall into the material handling market, which on a worldwide basis grew from around 750, 000 units in calendar year 2005 to 855,000 in 2006, and this rate of growth is expected to continue for the foreseeable future.

Table 5: Material handling market

Unit sales, 000s	**2005**	**2006**
Europe	304	353
North America	198	213
Asia	199	236
World	749	855

Jungheinrich/WTIS

This market can further be divided into warehousing equipment and counterbalanced trucks.

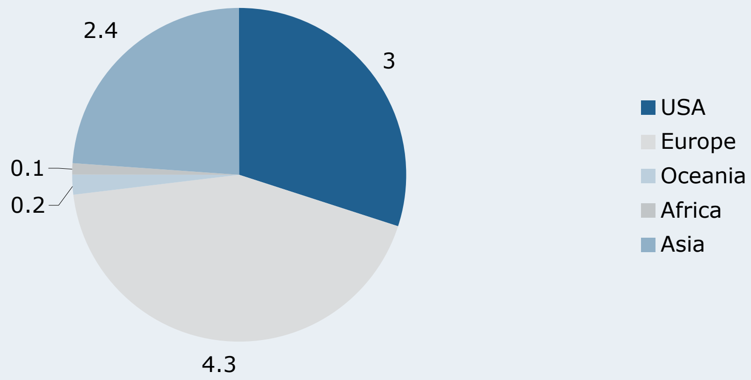
Table 6: Material handling equipment

Unit sales, 000s	**2002**	**2003**	**2004**	**2005**	**2006**
Warehousing equipment	228	236	269	289	329
Counterbalanced trucks	335	366	435	460	526
Total	563	602	704	749	855

Jungheinrich/WTIS

Approximately 10m forklift trucks are in use worldwide, of which the greatest numbers are found in Europe and the USA.

Figure 6: Installed base, units m



Industrial Truck Association / MHIA

Of this installed base, around 25% is battery-powered.

Forklifts can be categorised into 5 classes:

- Class 1 – electric motor, standing or seated operator, 3 or 4 wheeled, and counterbalanced. This is generally considered the industry workhouse;
- Class 2 – electric motor trucks for narrow aisles, possibly with extra reach or swing mast functions;
- Class 3 – electric motor trucks, walk-behind or standing rider. Automated pallet lift trucks;
- Class 4 – Fork lift trucks with cabs and seated operator. Internal combustion engines, solid or cushion tyres, typically counterbalanced;
- Class 5 – Fork truck with cabs and seated operator, internal combustion engines, pneumatic tyres and typically counterbalanced.

The major manufacturers of forklift trucks are shown below.

Table 7: Major Manufactures of forklift trucks

Position	Company	HQ
1	Toyota	Japan
2	Linde	Germany
3	NACCO Industries	USA
4	Jungheinrich	Germany
5	Mitsubishi-Caterpillar	Japan
6	Crown	USA
7	Komatsu	Japan
8	TCM	Japan
9	Nissan	Japan
10	Doosan	S. Korea

ED, various

EQUITY DEVELOPMENT

Buses

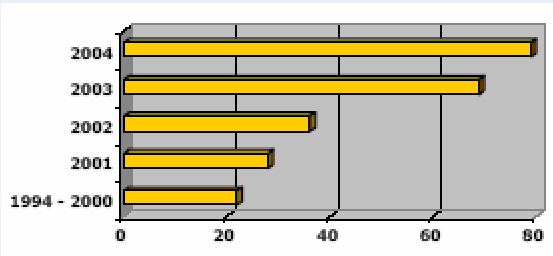
The attractiveness of bus fleets as an early market for fuel cell and hydrogen stems from:

- Central refuelling
- Predefined routes (so operators can calculate time between refuelling and distances)
- High public visibility
- Size and weight of the stack not being as critical as in the light duty vehicle market
- More design space for hydrogen storage tanks.

Global bus production has reached approximately 240,000 units per annum. There is perceived potential in the local bus sector – those buses operating in built up areas and moving relatively short distances from base. Proton estimates that approximately 25 per cent of this market could be addressed by a fuel cell solution with an average cost per application of approximately €25,000 and a total market value of approximately €1.5 billion per annum.

Fuel Cell Today's Market Surveys of 2004 and 2006 show a pronounced increase in the cumulative numbers of fuel cell buses produced in 2003/2004, reflecting demonstration programmes getting underway, and with little increase in numbers in the subsequent years as no new vehicles were introduced.

Figure 7: Cumulative number of fuel cell buses produced



Fuel Cell Today

Europe accounted for around 66% of the cumulative production to 2004, and the US and China 12% each. The range of fuel cell bus trials funded by the EU is shown in the Table below. The Mercedes–Benz Citaro with Ballard fuel cell technology features in the CUTE and Icelandic (ECTOS) trials, with 27 of these vehicles operational throughout Europe in 2006. Three of these Evobuses also featured in the STEP (sustainable transport energy for Perth) trials in Perth, Western Australia.

Figure 8: European funded fuel cell bus trials

	No. of Buses	Engine Configuration	Power Output (Stack Developer)	Bus Type	Onboard Fuel	Fuel Storage	Fuel Production
CUTE (2001 – 2005/6)							
Amsterdam, Hamburg, Stockholm	3	Direct	250 kW (Ballard)	Citaro (EvoBus)	CH_2	Gas Cylinders	Onsite electrolysis[1]
Barcelona	3	Direct	250 kW (Ballard)	Citaro (EvoBus)	CH_2	Gas Cylinders	Onsite *solar* electrolysis
London, Luxembourg, Porto	3	Direct	250 kW (Ballard)	Citaro (EvoBus)	CH_2	Gas Cylinders	Centralised off site production[2]
Madrid, Stuttgart	3	Direct	250 kW (Ballard)	Citaro (EvoBus)	CH_2	Gas Cylinders	Onsite SMR natural gas
ECTOS (2001 – 2005)							
Reykjavik	3	Direct	250 kW (Ballard)	Citaro (EvoBus)	CH_2	Gas Cylinders	Onsite electrolysis[1]
CityCell (2003 – 2005)							
Madrid, *Turin*[5]	1	Hybrid with battery storage	62 kW (UTC)	Cristalis (Irsibus)	CH_2	Gas Cylinders	Onsite SMR natural gas[3]
Paris[5]	*1*	*Hybrid with battery storage*	*75 kW (Axane)*	*Cristalis (Irsibus)*	CH_2	*Gas Cylinders*	
Fuel Cell Bus (1999 – 2002?)							
Berlin, Copenhagen, Lisbon	1 [4]	Hybrid with battery storage	75 kW	NL A21 (MAN)	LH_2	Cryo-cylinders	

1 – the electricity for electrolysis has been certified as "green",
2 – for the centralised production the hydrogen is tanked in, with London being the only city to tank in and store liquid hydrogen,
3 – the refuelling station in Madrid is being used by both the CityCell and CUTE project
4 – the Fuel Cell Bus project had one bus in total, unlike CUTE which has 3 per city,
5 – here italics represent planned buses that have not been delivered.

Fuel Cell Today

CUTE, for example, was concluded very successfully, and the initiative extended in the follow-up programme HyFLEET:CUTE, and the encouraging results across the board have led to further fuel cell bus orders which should see the cumulative total grow again in 2007 and 2008 (London is looking at having 70 such buses in operation by 2010).

Other noteworthy developments in 2006 include:

- The partnership between Shell Hydrogen, Connexxion Holdings and MAN Truck and Bus Company to initiate a project which aims to have more than 20 hydrogen buses and a refuelling station operational in Rotterdam by 2009 and which will run for a 5 year period;
- Hyundai Motor Company delivered the first of 10 Hyundai and Kia fuel cell electric vehicles, including a bus, to AC Transit in December 2006;
- The fuel cell company UTC Power combined forces with Van Hool to deliver a fuel cell bus to De Lijn, the largest bus fleet operator in Belgium;
- Proton Motor technology is used on a fuel cell bus operating in Barth (in Mecklenburg- West Pomerania) from September 2006. Proton's PM Turnkey hybrid system based on the PM Basic A 50 fuel cell system.

In February 2007 Proton began work on a €3.0 million contract for a city bus project launched in the Czech Republic. Developed in collaboration with Škoda Electric Pilsen, a leading manufacturer of trolleybuses, the new electric bus will operate in the Prague vicinity in 2009. Proton Motor will develop a fuel cell system for the bus using technology based on its dedicated bus fuel cell application. The deal, which is subject to commercial contract terms being signed, will generate revenue of approximately €1.1 million for Proton Motor over the course of approximately the next 24 months.

The project called Fuel Cells Czech Hydrogen-Bus (FCZ H2-BUS) is funded by the European Commission, as part of its infrastructure funding programme, and other Czech institutions. The Czech Nuclear Research Institute (UJV Řež) is acting as project coordinator, working with other Czech Republic partners.

Taking the forklift, bus, truck APU and the marine market sectors, and assuming the percentage of those sectors that would be applicable to fuel cell use, and pricing the fuel cell at €500 per kW, the potential addressable market stands at €8.8bn.

Table 8: Potential Market Size

	Annual global production	Fuel cell applicability	Application volume	Average power/unit	Potential addressable market at €500/kW
	units	%	units	kW	€ million
Forklifts	855,000	20%	171,000	20	1,710
Buses	240,000	25%	60,000	100	3,000
Truck APU	10m	8.50%	850,000	5	2,125
Marine	N/A	N/A	200,000	20	2,000
Total					**8,835**

ED, Company

FORECASTS

In the table below, the income from the licence sale to L3 Communications is shown in 2006 and 2007E sales, the bulk of this income having fallen in 2006. In terms of hybrid drive sales, we expect a strong relative performance in 2008E over 2007E as current projects progress and new ones are taken on, but the benefits of the new facility in terms of allowing significant capacity expansion and volume production are anticipated in 2009 onwards, with the potential for an order of magnitude increase in sales, followed by a solid move into profitability. We expect Proton Power Systems to become EBITDA positive in 2009, with operating profit from 2010.

Table 9: Profit & Loss			
Year to 31 December	**2006**	**2007E**	**2008E**
£ 000s			
Sales	481	657	1,774
Licence sale	576	24	
Cost of sales	-1,030	-1,067	-2,533
Gross profit	27	-386	-759
Gross margin	6%		
Other operating income	12	50	50
Administrative costs	-1,792	-1,656	-1,834
EBITDA	-1,753	-1,992	-2,543
Margin			
Depreciation	-44	-84	-502
Operating profit	**-1,797**	**-2,076**	**-3,045**
Margin			
Finance income	8	100	100
Finance costs	-11	-15	-15
Staff profit share	0	0	
Pre-tax profit	**-1,800**	**-1,991**	**-2,960**
Tax			
Net profit	-1,800	-1,991	-2,960
EPS basic, p	**-6.8**	**-6.3**	**-9.4**
EPS diluted, p	-6.8	-6.3	-9.4
Shares basic, 000s	26,370	31,391	31,391
Shares diluted, 000s	26,491	31,391	31,391

ED estimates

Historical results are presented below.

Table 10: Income statement		
6 months to 30 June	**2006A**	**2007A**
£ 000s		
Sales	718	295
Cost of sales	-680	-423
Gross profit	38	-128
Gross margin	5.3%	
Other operating income		25
Administrative expenses	-501	-882
Operating profit	-463	-985
Finance income		50
Finance costs	-14	-16
Pre-tax profit	-477	-951
Tax		
Net profit	**-477**	**-951**

ED estimates

Table 11: Balance Sheet

Year to 31 December	2005	2006
£ 000s		
PP&E	87	55
Intangibles	7	99
Non-current assets	94	154
Stock	0	21
Trade/receivables	30	956
Cash & cash equivalents	17	1,886
Current assets	47	2,863
Total assets	141	3,017
Trade & other payables	1,228	832
Current liabilities	1,228	832
Total liabilities	1,228	832
Total equity	-1,087	2,185
Total equity and liabilities	**141**	**3,017**

ED

Table 12: Cash Flow

Year to 31 December	2005	2006
£ 000s		
Net cash from operations	-857	-2,353
Cost of acquisition		-138
Purchase of intangibles		-98
Purchase of tangibles	-55	-9
Net cash used in investing	-55	-245
Share issue	574	3,644
Increase in loan balances	249	1,195
Loan repayments		-372
Reduction in other financial assets	75	
Net cash from financing	**898**	**4,467**
Increase/ (decrease) in cash & CE	-14	1,869
Opening cash & CE	31	17
Closing cash & CE	17	1,886

ED

VALUATION

As with many of its peer group, Proton is in a pre-commercial revenue and loss making stage. However, looking at a number of companies with a degree of traction in the vehicle and materials handling market (and FuelCell Energy, Inc, active in stationary power) some parameters emerge:

Table 13: Comparables

Company	Mkt Cap, m	Mkt Cap/07E Rev	Mkt Cap/08E Rev
Ballard (US$)	512	8.7	6.9
Fuel Cell Energy (US$)	617	14.0	7.1
Hydrogenics (US$)	102	2.8	2.4
Plug Power(US$)	237	16.9	11.3
Average		10.6	6.9

ED, Consensus

While fuel cells and power systems represent around 30% of Hydrogenics's business, and the Hydrogenics multiples reflect its non-fuel cell business, we have included them for the degree of conservatism they introduce. Applying the average multiples of this group to Proton’s forecast 2007 and 2008 revenues would give a valuation range of between £23m and £39m for the company. We believe that the strength of its global OEM partnerships and the applicability of its innovative hybrid drive system should readily justify the £23m value (73.2p/share), and further execution and expansion should see the £39m (125p) as a feasible near-medium term target.

I certify that this report represents my own opinions
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