

Home hydrogen generator offers local generation of a low-carbon fuel, to power cars and home heating

Wind turbines, solar-voltaic panels and tidal generators can produce low-carbon energy, but not always when or where it is needed. According to some experts, massive investment in green energy projects will be a waste of money until problems of storage and distribution are solved.

Sheffield-based ITM Power may have the solution. The company has developed technology that holds the promise of providing a cost-effective method of converting power from low-carbon, transient energy sources into hydrogen, which can be stored and transported. The gas can then be converted back to power when and where it is needed.

Dr Donald Highgate, until recently ITM Power's Head of Research, wrote a scientific paper in 1976, suggesting that hydrogen produced by electrolysing water could be the best and most cost-effective way of storing energy, if it could be produced economically and locally to where it was needed. Until then, producing hydrogen from water had involved massive capital investment in factory-scale processing, with the resulting gas being stored at very high pressure or as a liquid at very low temperatures and therefore difficult and costly to transport.

By the year 2000, Dr Highgate had used his specialist knowledge of hydrophilic polymer chemistry to design and patent a new type of fuel cell membrane based on low-cost hydrocarbon materials. The same low cost membrane is effective in electrolysis where it can avoid the need for the expensive platinum normally used as a catalyst. The membrane used in ITM's fuel cell costs \$5 per sq metre, as against around \$500 per sq metre for existing industry standard membrane materials. Dr Highgate's specialist knowledge also helped him to simplify the cell architecture and design a process for electrolysing hydrogen economically, in small quantities that could easily be stored close to where it would be used – in the home or to power a family car.

It took Dr Highgate and his fellow scientists at ITM a further eight years to incorporate the company's patented technology into the local re-fuelling station. The device, which is roughly the size of a large domestic fridge-freezer, should cost no more than a typical central heating boiler, once it is being mass produced. It is expected that hydrogen equivalent in energy value to a litre of unleaded petrol will cost about 80p and that this price could reduce as renewable energy generation technology is taken up widely.

ITM Power has demonstrated that its 'home-produced' hydrogen can power a Ford Focus, with only minor adjustments to the fuel intake. Enough hydrogen can be produced overnight, using low-tariff electricity, to power the car for 25 miles, which is more than the average commuter's round trip.

The company has also established a showcase 'hydrogen apartment' where home-produced hydrogen is used for heating, cooking and operating a fridge, while a hydrogen-powered generator and combined CHP system provides heat and the electrical power for lighting and to operate the television and DVD player.

Intellectual property rights essential in attracting investment

Robert Perry, a partner at patent attorneys Gill Jennings & Every LLP (GJE) and Donald Highgate's IP adviser since the 1980s, argues that without the protection against copying that ITM's patents give the company, it would have been impossible to make the long-term investment needed. "Donald Highgate has developed and patented some valuable inventions in the past," he explains. "For instance, he developed the first commercially successful hydrophilic co-polymer for contact lenses and sold the IP rights to one of the leading lens manufacturers.

"However, his vision for ITM is much broader," Robert Perry continues. "He believes that the company has developed a technology that will provide a ubiquitous means of converting low-carbon electricity into storable hydrogen, and converting it back into power when and where it's needed. Making this vision a reality requires a big investment, which is possible only if you have the confidence of your investors. With help from GJE, ITM has developed a long-term IP strategy and is building a portfolio of IP rights internationally."

According to Donald Highgate, ITM's original patent application for 'a hydrophilic cross-linked material containing an ionic moiety (acid or alkali) that could be used as a membrane' not only defined the broad field that ITM is now operating in, it was also essential in achieving an initial multi-million valuation of the company and attracting the first £1.4 million of investment in 2002.

Because of the need to demonstrate the strength of the company's IP position to investors, GJE requested accelerated processing of that first UK patent application and the IP Office granted the patent just 18 months after the application was filed. Since then the company has had patents granted in most of its major potential markets, including the USA and Europe. As part of its long-term IP strategy, ITM is continuing to file applications to patent specific technologies associated with the original application, including some that cover the manufacturing process. According to Robert Perry, the strategy is to "keep innovating and to keep patenting, so that ITM will continue to have value well into the future."

Donald Highgate is clear about the value of his long-standing relationship with GJE. "The advice and support I have had from Robert Perry has helped us to attract investments and government grants worth far more than the fees we have paid. For example, the total official and professional fees for obtaining our first patent in this field were just £10,000, and our research costs at that time were less than £1 million. The first investment was secured on the strength of that patent. Later, and again based critically on the IP position, ITM was valued at £50 million when it floated on AIM in 2004, and succeeded in raising £10 million in new investment."

Besides adding value to the company's commercial activities, a patent attorney's advice can also broaden the technical scope of its IP, says Donald Highgate. "When we were drafting the patent specification for an off-peak energy storage system for cooling – air conditioning – systems," he explains, "it was Robert Perry who pointed out that the same technology patent would also cover systems able to store high temperature energy for heating systems – effectively doubling the scope of the technology's potential applications."

Patents are the major part of the company's IP portfolio, but ITM has also invested in trade mark registration, including the brand 'H2 ready', which it is discussing with car manufacturers. "For about £200, new petrol engined cars

could leave the factory equipped with all the additional components needed to run on hydrogen, except for the hydrogen tank which would be added when hydrogen became locally available." says Donald Highgate. "They would then be able to run on hydrogen as well as their normal fuel. We are discussing a future marketing campaign to make consumers aware of the benefits of using locally generated hydrogen fuel, and the 'H2 ready' message will do for hydrogen power what the 'HDTV ready' message is currently doing for high-definition TV."

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Home hydrogen generator offers potential to store low-cost, green energy to power cars and home heating

PHOTOS: high-resolution JPEGs available from Peter Prowse:
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ITM 01

Dr Donald Highgate, ITM Power's Head of Research, shows how light and flexible his patented, low cost membrane is. The green home refuelling station behind is about the size of a domestic fridge-freezer and can produce hydrogen at a cost equivalent to £0.80p a gallon.



ITM 02

ITM Power's patent attorney Robert Perry, of Gill Jennings & Every LLP, has not only helped to add value to ITM's value, he has also suggested ways of broadening the technical scope of its inventions.



ITM 03

Unlike those used in existing fuel cells or catalysers, ITM's low-cost membrane's can be produced at very low cost and integrated into a single polymer moulding.