Technology Strategy Board
Driving Innovation

Innovation **results**

AN R&D CASE STUDY #017

Cheaper and more efficient fuel cells

Advanced electrode technology offers performance and cost savings for medium-temperature fuel cells that are being developed for stationary power generation markets.

The need

Greater use of combined heat and power (CHP) and distributed power generation (eg in hospitals and hotels) are key elements of the UK's energy and carbon-reduction strategy. Medium-temperature (150-200°C) fuel cells, such as phosphoric acid fuel cells (PAFCs), offer a reliable and efficient alternative to conventional, engine-driven CHP systems. However, their take-up has been limited due to significant installation costs. To help address this issue, the development of new electrode technology for the next generation of PAFCs aims to significantly increase the design life to 80,000 hours, thus improving the overall economics of a project.

The results

The electrodes used in PAFCs consist of a gas diffusion layer, onto which is deposited a highly structured catalyst layer of nanoscale particles of platinum.

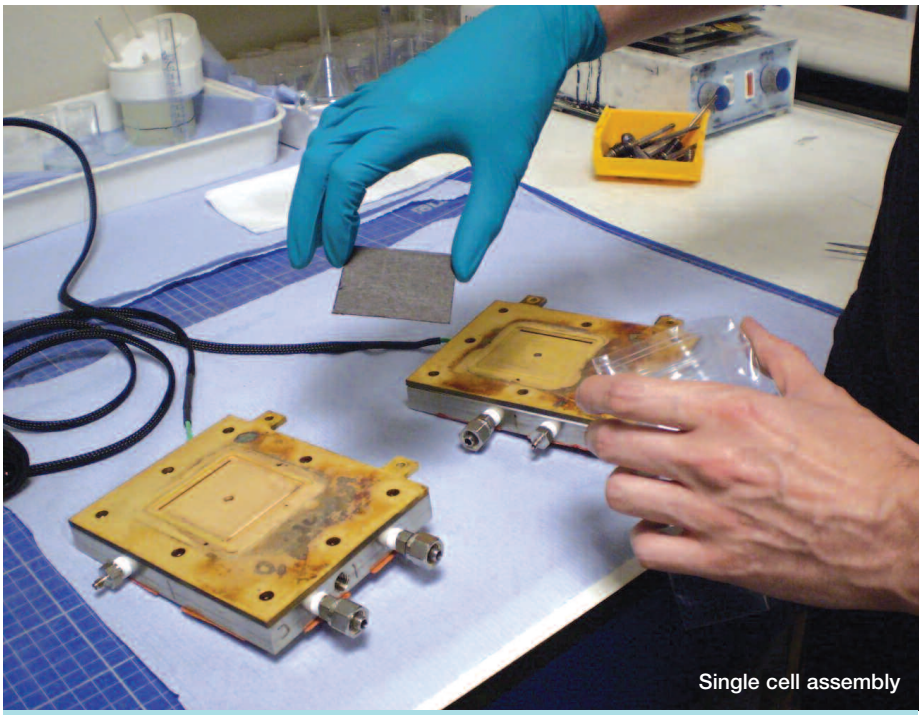
In this project, Johnson Matthey Fuel Cells developed a new gas diffusion layer formulation and fabrication process, and established a UK supply chain consisting of project partner, Technical Fibre Products, and a number of local sub-contractors. The new gas diffusion layer has much-improved mechanical strength, thermal conductivity and electrical conductivity. The materials are heat treated at significantly lower temperatures of around 2,000°C compared with current processing at between 2,500°C and 2,800°C. The material and design innovations mean the new gas diffusion layer costs up to around 40% less than the costs for the current process (depending on the application). The new gas diffusion layer also enables simpler and cheaper stack assembly (linking a series of fuel cells together).

The use of platinum is also a major cost. Johnson Matthey Fuel Cells has developed a new platinum/transition metal-alloy catalyst. It has a lower level of platinum and predicted improved performance under anticipated operating conditions. Accelerated lifetime testing over many thousands of hours confirmed the greater durability of the new electrode. This translates directly to an overall gain in the power generation efficiency of the fuel cell and, thus, to lower carbon emissions.

The structural requirements for these electrodes mean that conventional processes for forming electrode layers are not suitable. The project developed a completely different fabrication process and set up a pilot-scale unit.

What is a phosphoric acid fuel cell?

A PAFC is a type of fuel cell in which the electric charge released by the chemical reaction of hydrogen and oxygen (the reactants) is carried by liquid phosphoric acid (the electrolyte) between two platinum-coated carbon electrodes, generating an electric current. The properties of phosphoric acid require PAFCs to operate at between 150 and 200°C.



Single cell assembly

Test stand operation

HOW THE TECHNOLOGY STRATEGY BOARD MADE A DIFFERENCE:

‘The project allowed us to develop new expertise and a supply chain for a critical component.’

Market potential

Expansion of CHP installations in the UK has been limited by the relative lack of suitable sites for conventional technology (turbines, reciprocating engines). Fuel-cell technology is an alternative form of CHP with a wide operating range, and is clean, quiet and non-polluting (thus making urban locations more acceptable). However, fuel-cell penetration of the market is limited by the high capital cost of current systems (>£3,000 per kW).

Cheaper, higher performing electrode products will make a major contribution to cost reduction, offering savings of between 15 and 25% per system and allowing accelerated roll-out of the technology. Johnson Matthey Fuel Cells predicts that revenue from electrode sales into this new opportunity could grow rapidly from a zero base and reach several millions of pounds per year within the next 2–3 years.

Progress within this project has been so successful that electrodes from the new UK supply chain have been supplied to the leading international developers of PAFCs technology, with the first commercial orders being placed in early 2009.

Project # 200041

Project partners
Johnson Matthey Fuels Cells Ltd
Technical Fibre Products Ltd

Technology Strategy Board investment
£378,400

Total project investment
£1,513,800

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Technology Strategy Board
Driving Innovation

Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

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