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Solid oxide fuel cells could offer BYO power

By Gary Alcorn

Within 10 years Australian grain producers are likely to retain some of their harvest to produce ethanol for on-farm electricity and hot water generation.

Regional complexes could extract this grain-based fuel for use in compact solid oxide fuel cell (SOFC) generators providing a large degree of independence from the national electricity grid.

Ceramic Fuel Cells Limited (CFCL) Business Development Manager, David Peck, believes the fuel cell generator will find a home down on the farm, particularly in mixed enterprise operations.

"Our company is leading the world in this type of technology which can use methane, natural gas, LPG or gassified ethanol as a fuel. The only other inputs you need are fresh air and water. CFCL's market entry product is a domestic Combined Heat and Power system (Micro-CHP) that will produce one kW of 240 volt AC electrical power and sufficient hot water for a family of four. Larger systems for commercial applications are in the design pipeline," David says.

"Unlike an engine driven generator there is almost no vibration or noise and the only moving part is a small air circulating fan," he said.

Both grain and sugar producers could provide the raw materials for ethanol production, while the intensive livestock industries could generate methane from manure digesters.

The SOFC can be likened, in principle, to a lead acid battery where the sulphuric acid electrolyte is replaced by a zirconium ceramic membrane and rather than storing energy it converts gas to electricity on a continuous basis.

"There is no internal combustion — just an electrochemical reaction with negligible pollutant emissions. Instead the SOFC pro-

duces some water vapour and heat. Although carbon dioxide is emitted the high fuel conversion efficiencies mean that this can be up to 60 per cent less than from a conventional power station."

"These fuel cell CHP systems are expected to have a conversion efficiency approaching 80–85 per cent — well above coal fired electricity generation which hovers around 25 per cent," he said.

With SOFC on-farm installation the exhaust heat is also put to work heating

water that can account for 50 per cent of electricity consumption on dairy farms.

David said a demonstration project involving a five kW SOFC generator fuelled by a methane digester was currently under consideration for a Victorian dairy farm. He was also optimistic that grain growers would come up with hot air exhaust heating applications on their farms but was unable to say whether grain drying would be a feasible application before some evaluation was done.

What is a fuel cell?

There are six main types of fuel cells with the high temperature, high efficiency solid oxide (SO) and low temperature, lower efficiency proton exchange membrane (PEM) most likely to be seen in rural Australia.

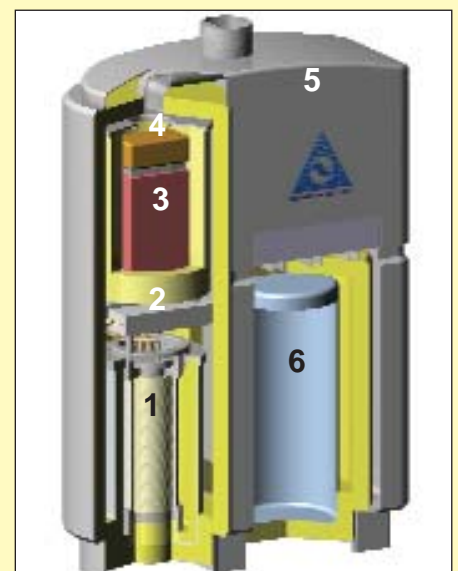
The SOFC will see service in a distributed electricity and heat generation market while PEMs with their quick start capabilities will be used in motor vehicles. However PEM cells require a pure source of hydrogen stored at up to 68,950 kPa (10,000 psi).

CFCL Executive Chairman Julian Dinsdale addressing an energy conference in Brisbane in January described a fuel cell as "consisting of an anode and a cathode separated by an electrolyte. Fuel is passed over the surface of the anode and oxygen from air is passed over the cathode."

"The anode and cathode are catalysts and the electrolyte can be solid or liquid depending on the conduction mechanism used for a particular type of fuel cell."

Depending on the types of components, a reaction occurs whereby ions are transmitted through the electrolyte causing

an electric current to flow when an external load is present. A typical open circuit voltage per layer is between 1.0 and 1.2 volts, he said.



- 1 Fuel cell stack
- 2 Fuel/air pre-treatment
- 3 Heat exchanger and burner
- 4 Pre-heater
- 5 Mains power converter and controls
- 6 Hot water tank

"A typical SOFC CHP system has three inputs — air, gas and water (for heating/cooling) while the outputs are AC electricity, hot water around 55°C and some hot air exhaust less than 100°C.

"The SOFC is designed to have a service life of 40,000 hours but will not be suitable for vehicles such as cars, trucks or tractors," he said.

Support components include a fuel desulfuriser and pre-reformer, exhaust treatment and heat recovery system, power electronics to convert the DC electricity from the stack into 240 AC mains power and a control system to coordinate the operation of all these systems.

The CFCL CHP unit could find a useful role as a backup power supply connected in parallel to the national grid or replacing it entirely in remote or unreliable areas.

What about the cost? David admits the initial cost will be substantial until economy of scale brings unit costs down to something near other alternative generation methods. He likens fuel cells to DVD players where prices started in the thousands and fell rapidly over a few years to around \$100 or less today.


"We have established a headquarters in

the UK to service the EU which buys around six million water heaters annually. A significant number of these have the potential to be combined with CHP fuel cell technology to generate electricity for use in the home and export to the grid.

The UK's Energy Savings Trust has estimated that cumulative Micro-CHP sales of 15 European countries and Norway would potentially rise up to 12 million units by 2020.

The concept of generating electricity at either individual houses or blocks of home units is already being evaluated in several European countries, especially in Germany and the UK.

"Field trials involving several hundred systems using various technologies from a number of suppliers are in progress. Fuel cells are emerging as a particularly attractive option for these applications because of their continuous base load supply capability, and potential for high efficiency and low emissions," David said.

CFCL is a publicly listed Australian company (ASX code CFU) and its major shareholders as at July 2004 were Metasource (a subsidiary of Woodside Petroleum), Energex and CSIRO. 

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