

**Development by Fuel**

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been an increase in SOFC units shipped. For example in Japan, SOFCs are starting to be used in trials for mCHP, with fewer than 20 installations in 2008 but a step-change increase planned over the next five years. The impact of the US based Solid Energy Conversion Alliance (SECA) programme is also starting to be felt with an increase in demonstration units and beta-type shipments to the US military. Paradoxically, due to the overall increase in shipments of all fuel cell types, this increase in SOFC units represents a decrease in actual market share. AFCs are still in the mix but shipments are still under 10 units annually.

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Due to increasing interest in fuel production and use we are now also starting to report on fuel use by unit. Please note that this is not a measure of quantity of fuel used but simply another metric of industry development.

We use five different fuel categories: Hydrogen, Methanol, Natural Gas, Petrol / Diesel and Other, with Other, covering the heavier crude oil distillates such as kerosene and JP-8, as well as town gas and biogas. Propane is included in the Natural Gas figures.

The graph on fuel types shows that over the last three years there has been a real swing between

the different fuels with units fuelled by hydrogen (compressed and liquefied) dropping from a 70% share of units shipped in 2006 to 17% in 2008. With the jump in sales of DMFC units it is no surprise to see the share of methanol-fuelled units increase from just 6% in 2006 to 67% in 2008. The 'Other' sector had some 20% of the market in 2006 representing, we believe, a number of test units from a large number of companies flirting with different fuel types and reformer technologies.

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All fuel cell types except DMFC, use hydrogen which can be produced from a variety of feedstocks. Feedstock choice is dependent on reformer technology being able to produce hydrogen at a high enough quality for use. At present we see oil-based derivatives petrol, diesel and kerosene having a tiny market share but this is due to the absence of suitable reformer technology rather than lack of interest. We expect their market share to increase with the rising focus on cornerstone markets such as the marine and defence industries, where single-use fuel is highly desirable and for the foreseeable future this fuel needs to be oil-based.

Since 2006, the use of direct hydrogen has become increasingly application-specific with the development of reformer technology for a range of other fuels, primarily natural gas and city gas. Note that city gas is specific to Japan. This development and availability of some reformers has allowed the apparent increase in the use of natural gas, especially in the mCHP sector where it is seen as an enabler to diffuse the technology through the current energy supply companies.

The apparent tailing off in patent activity since 2006 is largely an artifact of the data since it can take several years from the date of filing for a patent to be granted

around a dozen entities, most located in Brazil, which has the most developed fuel cell and hydrogen R&D sector. The Brazilian National Commission on Nuclear Energy has submitted the most applications, with five. The rest are spread among several universities (located in Brazil and Mexico), several energy and mining companies, and two Brazilian fuel cell companies – Electrocell and Clacoper. This reflects the current focus on fundamental R&D, as opposed to commercial development, within these four countries.

Overall, the patent trend suggests that development of a domestic fuel cell industry is still in its early stages, with much greater emphasis on fundamental research activities, but the large number of patents granted to international companies suggests that they do see the potential for fuel cell adoption in this region.

## Argentina

Argentina is one of the potentially promising emerging markets for fuel cells in Latin America, but to date, there have been only low levels of government attention paid to hydrogen or fuel cells, and little has been done to test and seed the potential market in the stationary and transport applications, at least publicly. However, there are some recent initiatives that may point the way toward increased R&D or demonstration activity, especially in the area of hydrogen production from wind energy and remote stationary applications, and building a market for fuel cells.

The country has recovered from the major economic crisis that took place from the late 1990s to 2002 to become one of Latin America's fastest growing economies. Although its GDP has still not returned to the pre-crash levels, it has been growing at a rate of between 8 and 9% annually since 2003. Its per capita GDP is £2,628 (\$4,731), above the average for the region. Industrial production has been growing at around 10% annually since 2003. This economic health could be threatened by the global economic crisis, which may have a greater impact in Argentina than in other Latin American countries due to its huge government debt.

## South Africa

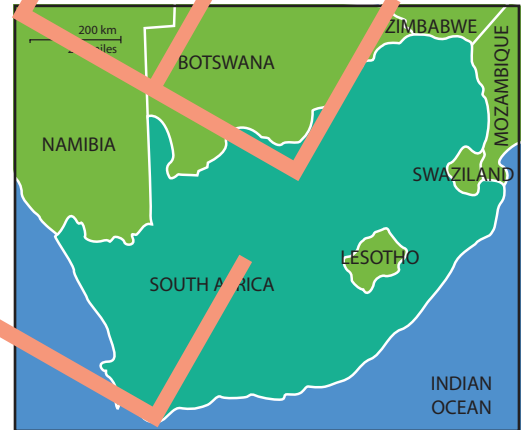
Following a Long-Term Mitigation Scenario (LTMS) study regarding climate change, South Africa's Department of Environmental Affairs and Tourism is weighing up the country's strategic options to mitigate climate change, and looking to fast-track the findings into policy directions. The LTMS outlines the basis for a national policy on climate change. There is a National Climate Summit and Science Conference planned for early 2009, which is set to begin the process of translating the LTMS into fiscal, regulatory and legislative packages as well as launching sectoral implementation plans.

South Africa holds over three quarters of the world's known platinum supply and has vast resources of coal. To take advantage of these resources South Africa's Department of Science and Technology has developed a strategy for Hydrogen and Fuel Cell Technologies, which was approved by the government in May 2007. The primary goals include wealth creation through high value-added manufacturing of platinum group metal catalysts and developing local cost competitive hydrogen generation solutions. These solutions would build on existing knowledge of high-temperature gas-cooled nuclear reactors and Fischer-Tropsch coal gasification technology. One of the Government's objectives is to supply around 25% of catalyst demand for the global fuel cell industry by 2020.

To kick-start its Hydrogen and Fuel Cell Strategy, South Africa has committed £26 million (\$47 million) over the three years leading to 2010 to put in place the necessary R&D and education infrastructure. Of this, 80% will be used to develop expertise and technology, and the remainder will be used to stimulate private sector funding. South Africa intends to use part of the Hydrogen and Fuel Cell Strategy budget to implement a basic hydrogen refuelling infrastructure to attract fuel cell vehicle manufacturers to demonstrate their vehicles during the 2010 Football World Cup.

If South Africa is to achieve its ambitious targets, it is important that the country has a solid skills base to support these efforts. The University of Cape Town's Centre for Catalysis Research is central in coordinating research activities related to hydrogen and fuel cells amongst higher education institutes and government bodies. Vaal University of Technology is undertaking a broad range of fuel cell research on AFC, DMFC, and PAFC. The University of the Western Cape is also undertaking a range of fuel cell related research in the fields of hydrogen production, storage, DMFC and PEM. The development of hydrogen and fuel cell start-up companies will be a determining factor in whether the country succeeds in fostering an indigenous hydrogen and fuel cell industry.

UPS and back-up power offer the most potential for early fuel cell adoption in South Africa. The country has a shortage of electric power generating capacity. In February 2008 this resulted in rolling power cuts which brought traffic, businesses and homes to a standstill for several hours at a time. The government of South Africa has pledged to rectify the situation and have all power shortage concerns resolved within seven years. At the same time the government intends to ensure that by 2012 electricity is made available to the remaining fifth of the population that does not yet have access to it. The government is looking to energy saving and renewable technologies to assist in meeting these targets.



South Africa and neighbouring countries

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## Fuel Cell Shipments by Application and Region

Due to the sensitive period of development that the fuel cell industry is still in, and to protect confidential information that has been given to Fuel Cell Today, all numbers have been rounded to the nearest thousand units.



## Fuel Cell Shipments by Electrolyte Type

During the forecast period 2009-2013, we expect the number of DMFC and PEM units in portable and transport units to heavily outweigh the number of large PAFC and MCFC stationary units, and SOFC units in a variety of applications. To illustrate the pattern of growth in shipments by electrolyte, we show the annual rate of change in shipments (by electrolyte) instead of the absolute number of units.