

## Fuel Cell Market Survey: Residential Applications

20 February 2002

Much has been written about the potential of small stationary fuel cell systems as power supplies in homes and similar applications, and many estimates have been made about how many units might be sold in the future. However, little data has been gathered on the activity that has already taken place. This survey aims to address this imbalance.



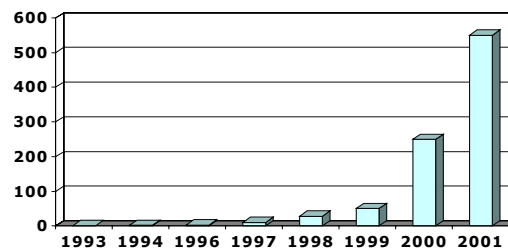
*UTC Fuel Cells 5kW Residential Fuel Cell. Source: UTC Fuel Cells*

So far, we estimate that a total of 550 residential-style fuel cell systems have been built and operated worldwide. This number not only includes systems installed in homes but also units in the 0.5-20kW range that have been operated in other related stationary applications, including uninterruptible and back-up power supply in commercial and remote locations.

Indeed, a number of developers (including **Avista Labs**, **Fuji Electric**, **Idatech**, **Plug Power** and **Teledyne**) have indicated that the first commercial products they release will be for non-residential markets, where low cost is not so important and competition from existing technologies not so fierce.

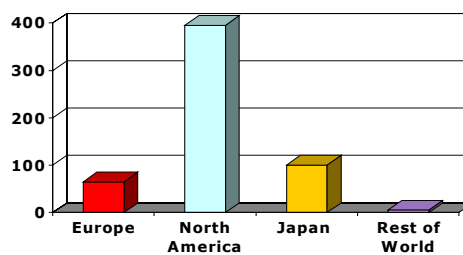
As the chart below indicates, development has accelerated rapidly in the last two years, with over 90 percent of the prototype systems built to date being constructed in 2000 and 2001. This growth is the most dramatic of any fuel cell application.

### Cumulative Number of Systems



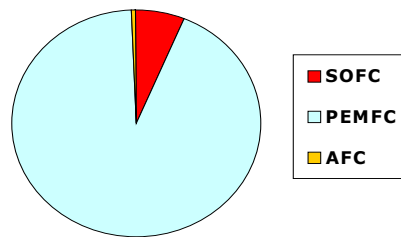
Before February 2002 more systems have built in North America than the rest of the world together. The dominance of the USA and Canada is, however, slightly misleading. Although a greater number of systems have been built and operated there (notably by **Plug Power**) there are as many system developers in Japan, and many companies there are making good progress towards commercialisation.

### Region of Operation



So far as technology type is concerned, most of the systems in this survey use proton exchange membrane (PEM) fuel cells. However, a number of companies are developing systems based on solid oxide fuel cell (SOFC) technology, which is looking increasingly promising in this application, particularly on the key issues of cost and efficiency. These include **Fuel Cell Technologies Ltd** and **Sulzer Hexis**, which is now starting large scale field trials of a pre-series system in conjunction with utility partners in Germany.

## Technology



The power output of residential systems can vary greatly, ranging from 0.5kW to 10kW. There are several reasons for this. In Japan, for example, where most systems under development are around 1kW, power consumption of households is lower, and most systems will operate in urban areas and provide power in parallel with the grid. In North America, where systems range in size from 3kW to 10kW, power consumption is much higher. In addition, bigger units are being developed to act as stand-alone power sources for remote homesteads.

So far as fuel choice is concerned, the majority of the systems included in this survey run off natural gas, and a great number of system developers have development or distribution agreements with suppliers of natural gas. In Japan several gas utilities (including **Tokyo Gas** and **Osaka Gas**) are active in the development of reforming technology and the promotion of fuel cells, which should increase demand for gas. In North America a number of companies are also developing systems that run off other fuels, notably **Idatech** (methanol) and **H Power** (propane as well as natural gas).

Although 2002 will not see commercial residential systems on sale (which some people were led to believe might happen) it should be an exciting year for the sector. Field trials of 10s of units are already underway in several regions, and the number of systems being built and operated should again jump significantly.

Events to look out for include Phase 2 of the Japan Gas Association's residential demonstration programme and the installation of CE (European Conformity) certified units by **Vaillant** and **Sulzer Hexis** in Europe. Meanwhile, **H Power** is expected to extend its US testing and demonstration programme with partner **ECO** (Energy Co-Opportunity), and the US Department of Defence is starting a residential fuel cell demonstration programme in various military installations.

The residential fuel cell sector is notable for the large number of developers involved. Below are brief details on a number of companies active in this area.

**Ebara Ballard** is developing 1kW PEMFC stationary co-generators for the Japanese residential market in conjunction with **Tokyo Gas**, which is developing the necessary natural gas reforming technology. A number of prototypes were constructed in 2001, and a commercial system is scheduled for introduction in 2004.

**Fuel Cell Technologies Ltd** is developing solid oxide fuel cell systems for residential applications, using 5kW stacks manufactured by **Siemens Westinghouse**. These will provide power and heat in residential, small commercial, and remote facility applications.

**Fuji Electric Co Ltd** is developing PEMFC systems up to 10kW in size, but has so far only unveiled one 1kW prototype. It is targeting commercial rather than residential markets first, and aiming to introduce a commercial product in 2005.

**H Power** is developing residential PEMFC systems, initially for grid-independent remote applications. It has extensively tested natural gas and propane in conjunction with its development partner, **Energy Co-Opportunity** (ECO). It is also working with **Osaka Gas** on the development of 500W and 1kW systems for the Japanese market.

**Hamburg Gas Consult GmbH** has successfully completed field tests of a number of 3.5kWe first generation Alpha PEMFC CHP prototypes in Europe, developed in conjunction with **Dais Analytic**. It expects to start testing beta units in 2003 with a view to commercialisation in 2004-5.

**Idatech** is developing 4kW systems fuelled by reformed methanol for remote residential applications. Field trials of several Alpha units conducted through the **Bonneville Power Administration** have taken place since 2000, and testing of second generation Beta systems is now underway.



*Idatech 3kW PEMFC, fuelled by methanol. Source: Idatech*

**Matsushita Electric Industrial Co Ltd** is developing compact residential PEMFC cogeneration systems with a view to introducing a commercial product in 2004. Two 1.3kW systems now being tested by the Japan Gas Association are amongst the most advanced of their type in Japan, principally owing to Matsushita's experience with related component technology as a battery developer.

**Nuvera** is developing 5kW PEMFC systems to supply primary or auxiliary back-up power to residential homes. Since May 2001 it has been working with European utility **RWE** on the development and distribution of these systems in Europe. **RWE** has so far received one prototype. Work on a second generation prototype designed for cost reduction and manufacturability is underway.

**Plug Power** is developing stationary fuel cell systems in the 4.5kW range, for grid connected operation fuelled by natural gas. Almost 250 units have so far been built and operated. In February 2002 it indicated that its first commercial system, which will be available from 2003, will be designed for the back-up power rather than residential markets.

In Germany **Proton Motor GmbH**, a developer of PEMFC systems, is participating with **Robert Bosch GmbH** and other companies in a government project to develop a CHP fuel cell system for residential heat and power supply.

Based in Texas, **Reliant Energy** is developing 7.5kW PEMFCs for residential and small commercial markets. A proof of concept prototype was constructed in 2001 and field trials of several units are scheduled to begin later this year.

**Sanyo Electric Co Ltd** plans to commercialise a 1kW residential PEMFC from 2003 to 2005. Since August 2001 it has been working on system development with **Osaka Gas**, who will supply the reforming technology.

**Sulzer Hexis** is leading the world in the commercialisation of SOFC technology with its development of an integrated, compact SOFC system for residential applications. Field trials of at least 200 units of its pre-series model, the HXS 1000 Premiere ("The fuel cell for single-family homes") are now beginning with distribution partners including German utilities EWE and EnBW.

**Toyota** is setting a precedent for auto-makers world-wide in its development of a 1kW PEM co-generator for residential applications. A prototype is currently being tested by the Japan Gas Association as part of its residential fuel cell programme. In June 2001 it was reported that Toyota has a target date of 2008 for the commercialisation of such a system.

**UTC Fuel Cells** has over thirty years experience developing fuel cells for residential applications, having first installed a prototype 4kW system fuelled by natural gas in an Ohio home in 1968. It is currently designing a residential/light commercial fuel cell power plant, rated at 5kW, designed to use natural gas or propane as fuel. Named the *Energy Centre*, this product can be used in conjunction with the electrical grid or with additional power plants for remote applications. Distribution partners include **Buderus Heiztechnik GmbH** and **Toshiba International Fuel Cells Corp.**

Other companies developing small stationary fuel cell systems include **Avista Labs, DCH Technology, Global Thermoelectric, Sanko Jidokiki, Teledyne,** and **Vaillant.**

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This review will be regularly updated in order to give an indication how the various markets discussed are developing. If you know of, or are involved in, any projects that should be included in this survey, please let us know. Information can be emailed to [marketsurvey@fuelcelltoday.com](mailto:marketsurvey@fuelcelltoday.com)