A wide variety of technologies are available to provide heating and electricity to our homes. In countries with a stable electricity grid, lighting and heating are taken for granted; but the desire for cleaner energy is highlighting how dirty grid electricity is around the world, and concerns over the future of nuclear power are adding to the debate. Many countries also have a network that distributes natural gas, and off-grid options such as heating oil or LPG are available, but when burned in conventional boilers these fuels only produce heat.

Combined heat and power (CHP) is the term used for when electricity and heat are co-produced from a single source of fuel, such as natural gas, and when done on a residential scale this is known as micro-CHP. Micro-CHP can replace or supplement grid electricity as a form of distributed generation of power in customers’ homes, and producing energy at the point of use avoids transmission losses.

**Background**

Fuel cells are well suited to micro-CHP, because the technology inherently produces both electricity and heat from a single fuel source, and the systems can run on conventional heating fuels such as natural gas. The electrical efficiency of fuel cells is higher than conventional electricity generation (over 45% compared to 25–35% for conventional combustion), and when the heat is used total efficiency of fuel conversion can approach 98%. This means that carbon dioxide emissions can be significantly reduced.

These fuel cell systems can be eligible for feed-in tariffs, allowing any excess electricity to be sold to the grid, and they can also complement other domestic renewable energy generation such as solar PV panels. Currently, fuel cell units are being installed in detached houses, but smaller systems geared towards apartments are in development.

**KEY BENEFITS**

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**Fuel Cell Types Used In This Application Today**

**PEMFC**

In this application proton exchange membrane fuel cells (PEMFC) run during the day when electricity demand is higher and can be switched off at night when electricity and hot water demand is low. This cycling can be done without harming the fuel cell and increases the overall efficiency of the system. Grid connectivity is required to start the unit each day, but a fully off-grid system with its own battery is available for a premium.

**SOFC**

Solid oxide fuel cell (SOFC) units are being introduced to residential micro-CHP schemes, with efficiencies on a par with PEMFC systems, but they should be run as continuously as possible in order to prolong the life of the system. Because SOFC run at higher operating temperatures than PEMFC, they are more tolerant of carbon monoxide in the fuel and this allows for some simplification of the system configuration.
Japanese Ene-Farm Scheme

The Japanese Government has supported the commercialisation of fuel cells in residential heat and power through the Ene-Farm scheme – the name derived from the term Energy Farm.

The project began in the 1990s with research leading to the development of a 1 kW PEMFC system fuelled by city-gas-derived hydrogen to produce heat and power for private homes.

This led to the demonstration phase which took place between 2003 and 2005 with fewer than 50 units installed. From 2005 the large-scale demonstration project began; this ran until 2009 and close to 3,000 micro-CHP fuel cell systems were installed.

The commercialisation phase began in 2009, and in the past three years more than 20,000 units have been installed in homes with subsidies available from the Japanese government to assist with the capital cost.

Ene-Farm fuel cells are distributed by the major regional gas companies, who also maintain the fuel infrastructure. There are three main manufacturers of fuel cell systems for the scheme: Panasonic (PEMFC), Toshiba (PEMFC) and JX Nippon Oil & Energy, trading under the Eneos Celltech brand (PEMFC and SOFC).

Since introduction, Ene-Farm systems have continually improved. The latest version offered by Tokyo Gas has a reduction in rated power from 1 kW down to 0.7 kW, more closely matching the electrical demand of Japanese homes. It offers a 3% improvement in electrical efficiency (LHV) and occupies 49% less floor space. These improvements were made while at the same time decreasing cost by 20%. Continued cost reduction will be vital to the long-term success of the scheme, and increasing sales volumes can only help.

The spectacular growth in sales to date is expected to continue, and in 2012 it is hoped almost 20,000 units will be sold, rising to a sales target of 50,000 units per year by 2015. In the future a much smaller Ene-Farm system (50% of the current size) is planned for installation in Japanese apartment buildings.

The success of Ene-Farm has inspired demonstration projects elsewhere in the world including Korea, Denmark, Germany, the USA and Great Britain.

Image sources: Akihabara News; Kyushu University; Fuel Cell Insider; Panasonic