Key Findings

Costs for stationary fuel cell applications still vary widely – from $2,500/kW for some technologies to more than $40,000/kW for direct methanol fuel cells.

Although fuel cell costs are still uncompetitive, the sector is still highly mature – revenues from commercial fuel cell companies were still under $500m 3 years ago although other estimates place the overall market size much higher.

Commercial fuel cell installations have risen sharply – more capacity has been installed in the past 3 years than in the 10 years prior to that.

Based on generation costs, fuel cells are becoming competitive with onshore wind and may be as little as 17% more expensive in some cases per MWh.

Fuel cell installations under 10kW have also grown quickly – at a CAGR of almost 50% between 2001 and 2007.

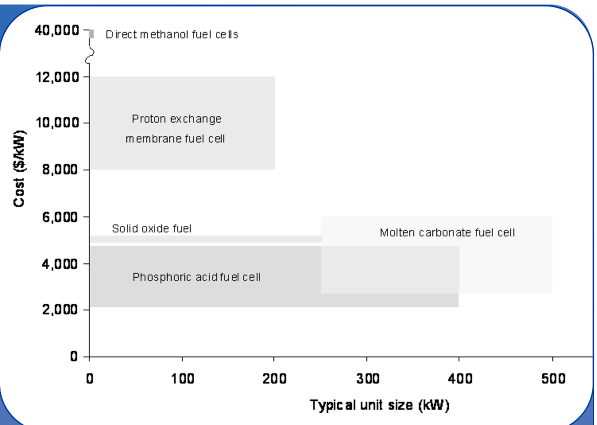

Figure 9.2: The cost of fuel cells for stationary applications ($/kW)

"Typical estimated prices for MCFCs is $3,000/kW - $5,000/kW. FuelCell Energy, which has the most installed units, claims that existing units can generate for around $0.15/kW which, while still more expensive than the generation cost quoted above for a PAFC, could prove competitive in the distributed generation market..."

Use this report to...

- **Identify the leading fuel cell technologies, their development status and application** with this report's in–depth analysis of the 6 leading fuel cell technologies:
  - **-Phosphoric acid fuel cells**
  - **-Proton exchange membrane fuel cells**
  - **-Molten carbonate fuel cells**
  - **-Solid oxide fuel cells**
  - **-Alkaline fuel cells**
  - **-Direct methanol fuel cells**
- **Compare the economic competitiveness of the different fuel cell technologies** with this report's comparative analysis of costs against existing power generation technologies.
- **Assess the long term potential of fuel cells in the stationary power market** based on this report's assessment of the future prospects of fuel cells, their commercialization prospects, key installation data and emerging fuel cell trials.

Explore issues including...

Cost competitiveness. Fuel cells are becoming more cost competitive, although costs for many of the technologies remain estimates and the true challenge for commercialization of fuel cells remains to be fully understood.

Technological immaturity. Fuel cells are still a highly immature technology, with relatively low, but growing levels of installation – and it is clear that a key feature of their uptake will be an ability to achieve scale.

The hydrogen economy. In the uncertain event that a hydrogen economy does develop, then the fuel cell is likely to become one of the primary means of exploiting hydrogen. The availability of hydrogen without the need for reforming would have a significant effect on the economics of several types of fuel cell.

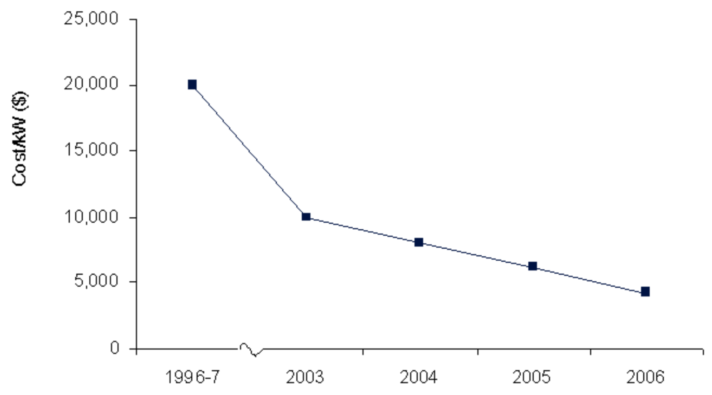

Figure 5.1: MCFC fuel cell costs and cost reductions ($/kW), 1996-2006

FCE is aiming for an installation cost for its fuel cells of below 2,000/kW. Meanwhile it claims to be able to supply power from existing installed units for $0.15/kWh in 2008 and is aiming for close to $0.10/kWh by 2010.

Discover...

- What are the leading fuel cell technologies?
- Which technology is suited to which application?
- What are the operational parameters for each technology?
- How do the economics of fuel cell technologies compare against one another and against existing power generation technologies?
- What is the growth profile for large and small fuel cell installations?
- What are the future prospects for fuel cell commercialization?

Sample Information

Chapter 4: Proton exchange membrane fuel cells

PEM cell technology

As with all fuel cells, the key feature which distinguishes the PEM cell is its electrolyte, in this case an organic polymer that is formed into a solid membrane. In the original Gemini space program, the membrane was a polymer of a compound called polystyrene-divinlybenzene sulfonic acid but this material has a limited lifetime and other polymeric materials are preferred today.

The materials that are currently most commonly used for PEMFCs are based on polymers of perfluorocarbon sulfonate. These polymers, which are manufactured by companies such as DuPont de Nemours, and Dow, are stable up to 100°C. Typical of them is Nafion, produced by DuPont, which has been used in PEM fuel cells for 40 years. The backbone of the polymer is virtually the same as that of Teflon but it has acidic sulfonate groups attached to it. As a consequence the polymer is acidic in nature and this is what provides its proton conductivity .

Table 4.6: Proton exchange membrane fuel cell characteristics

Cell reaction	$2H_2 + O_2 = 2H_2O$
Cell Electrolyte	poly[perfluorocarbon sulfonate]/water
Cell electrodes	carbon
Catalyst	Platinum/platinum alloy
Cell fuel	Hydrogen and oxygen (from air)
Reformer	External
Cell Voltage	0.7V
Electrical efficiency	50%
Overall efficiency	42%*
Operating temperature	80°C
Proven cell lifetime	Up to 40,000h claimed
Catalyst tolerance	CO <10 ppm
	SO_2 Zero

* This appears to be the upper limit for industrial applications where low grade heat cannot be utilized effectively. Home units can use this heat and efficiencies as high as 81% are being quoted for these systems.

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Though well established, the continued use of these traditional polymers for PEM fuel cells is now under question. They are considered relatively expensive and their long term stability within the fuel cell environment, where lifetimes of 40,000h or more are being sought for stationary applications, may be questionable. In addition their production involves the use of what are today considered hazardous chemicals. As a consequence new polymers are being developed and these are beginning to appear in commercial PEM fuel cells.

The fuel cell polymer is always used in membrane form. In appearance it resembles the plastic wrapping material used for food, but is slightly thicker, varying in thickness from 50 microns to around 175 microns (equivalent to between two and seven sheets of copier paper). In order to function as an electrolyte the membrane must be saturated with water since this provides the conductivity for positively charged hydrogen ions. Fortunately it absorbs water readily and has other valuable properties for fuel cell applications too; the membrane in impermeable to gas so the fuel gases cannot pass through it, is a good electrical insulator so electrons released at the anode cannot take a short circuit through the cell membrane to reach the cathode and it is relatively strong.

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