

Type	Acronym	Technology Characteristics				Fuel Source		Technology Development			
		Electrolyte	Operating Temperature	Efficiency (HHV)	Power Density	Fuels	Reforming	Stage of Development	Materials	Issues	Uses
<b>Alkali</b>	AFC	Potassium Hydroxide	50-200°C	45-60%, up to 70% w/CHP	0.7-8.1 kW/m <sup>2</sup>	H <sub>2</sub>	External	mature technology	Platinum catalyst	Requires very pure H <sub>2</sub> , platinum	Space vehicles
<b>Polymer Electrolyte</b>	PEM	Polymer Membrane	50-100°C	35-55%	3.8-13.5 kW/m <sup>2</sup>	H <sub>2</sub> Reformate	External	prototype	Platinum catalyst.	Small amounts of CO will poison catalyst.	Automobiles, buses
<b>Direct Methanol</b>	DMFC	Polymer Membrane	50-200°C	40-50%, up to 80% w/CHP	1.0 - 6.0 kW/m <sup>2</sup>	Methanol, ethanol, gasoline	not required	prototype	Platinum catalyst		Small CHP, transportation, portable
<b>Phosphoric Acid</b>	PAFC	Phosphoric Acid	160-210°C	40-50%	0.8-1.9 kW/m <sup>2</sup>	H <sub>2</sub> Reformate	External	commercially available	Platinum catalyst	If the hydrocarbon fuel is gasoline, sulfur must be removed.	Medium CHP, buses
<b>Molten Carbonate</b>	MCFC	Lithium or potassium carbonate	600-800°C	50-60%, up to 80% w/CHP	0.1-1.5 kW/m <sup>2</sup>	H <sub>2</sub> /CO/ Reformate	External or Internal	full-scale demonstration	Nickel catalyst	Less prone to CO "poisoning" than lower temperature fuel cells.	Large CHP
<b>Solid Oxide</b>	SOFC	Ceramic composed of calcium or zirconium oxides	500-1000°C	50-65%, up to 75% w/combined cycle and CHP	1.5 - 5 kW/m <sup>2</sup>	H <sub>2</sub> /CO <sub>2</sub> / CH <sub>4</sub>	External or Internal	prototype	Ceramic		All sizes of CHP

### Sources

- The Future of Power Production ©2001 Mar 22 by Ben Wiens <http://www.benwiens.com/energy3.html#energy1.10>
- Fuel Cells for Distributed Power, Ben Weins June 1999 (pdf)
- DOD Fuel Cell Program <http://www.dodfuelcell.com/fcdescriptions.html>
- (2) 2000 Future Car Congress-Paper 00FCC-10
- Smithsonian Institution <http://americanhistory.si.edu/csr/fuelcells/index.htm> Collecting the History of Fuel Cells: A Smithsonian Research Project
- The Hydrogen and Fuel Cell Investor, Table of Fuel Cell Types <http://www.h2fc.com/table.html>