

Fuel Cell Chart

	Phosphoric Acid Fuel Cell	Proton Exchange Membrane Fuel Cell	Liquid Molten Carbonate Fuel Cell	Solid Oxide Fuel Cell	Alkaline "APOLLO™" Fuel Cell (1)	Direct Methanol "MARS" Fuel Cell (2)
	PAFC	PEM	MCFC	SOFC	AFC	DMFC
Electrolyte	Liquid Phosphoric Acid	Ion Exchange membrane (solid polymer)	Liquid Molten Carbonate	Ceramic	Potassium Hydroxide	Potassium Hydroxide-
Catalyst	Platinum	Platinum	Nickel	Perovskites	Platinum/Palladium	Platinum/Ruthenium
Cell Operating Temperature (degrees C)	205	Room temperature to 80°C	650	800-1000	Room temp. to 80°C	Room temp. To 70°C (3)
Electrical System Efficiency (% LHV)	36-45	32-40	43-55	43-55	50-60	>50
Some Applications	√	√	√	√	√	
Cogeneration	√		√	√	√	
Utility Power	√		√	√	√	
Distributed Power	√	√	√	√	√	
Utility Repowering	√		√	√	√	
Passenger Vehicles		√			√	√
Heavy Duty Vehicles	√	√		√	√	√
Portable Power		√			√	√
Specialty Power		√			√	√

1. The APOLLO™ FUEL CELL is being developed by Apollo™ Energy Systems, Inc (AES). It is an Alkaline Fuel Cell with circulating electrolyte, which can be shut down when not in use. This extends life of the electrodes and allows for maintenance. It has a higher voltage than the other types of Fuel Cells. Patents have been applied for by AES on this fuel cell and a working model is in operation at AES's laboratory in Fort Lauderdale florida.
2. The MARS FUEL CELL is being developed by Apollo™ Energy Systems, Inc.. It is a Direct Methanol Alkaline Fuel Cell with circulating electrolyte and a polyethylene separator (proton exchange membrane separator not needed). The anode catalyst draws hydrogen from the liquid methanol, eliminating the need for a reformer. The carbon dioxide produced stays in the electrolyte as a liquid carbonate ($K^2 CO^3$ [or Na^2CO^3 if sodium hydroxide is used instead of potassium hydroxide]), which can be pumped out periodically and exchanged for fresh potassium hydroxide (or sodium hydroxide). There are no CO^2 or other emissions from the alkaline DMFC (there are CO^2 emissions from the acidic [H^2SO^4] DMFC). Cell voltage of the alkaline DMFC is higher than the acidic DMFC. Patents have been applied for by Apollo™ Energy Systems, Inc. on the Direct Methanol Alkaline Fuel Cell.
3. Or higher temperature if methanol vapor is used.