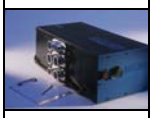
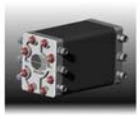
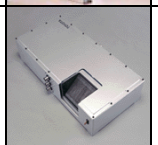
FUEL CELLS 2000
www.fuelcells.org

TRANSPORTATION FUEL CELLS – Market Info.

Company Name	Product	Market Entry Date	Price	Picture	Where Demonstrated	Comments
Acumentrics	Super Cell					They are exploring varies applications such as: Portable and stationary SOFC for the Broadband, Commercial, Residential, Remote, and Auxiliary Vehicle markets
Arotech (formerly Electric Fuel Corp.)	Large-scale zinc-air fuel cell stacks for heavy-duty electric vehicles including transit buses	Demonstration phase			Germany and Sweden, 13 postal vans; Italy several vehicles; USA, 40-ft transit bus	Arotechl recently demonstrated its ultra-capacitor/zinc-air fuel cell bus. Phase IV of the FTA cost shared program will begin next month. (11/2003)
Asia Pacific Fuel Cell Technologies	3 kW stack	Testing				Currently integrating this stack into a fuel cell powered scooter. Will also be used for golf cart, bike, boat, and stationary power For more information: http://www.apfct.com
Asia Pacific Fuel CellsTechnologies	Fuel Cell Powered Scooter	In development 2005 in Taiwan			3rd Generation fuel cell scooter completed July 2002 Commercial production targeted for 2003	58km/hr max speed DuPont Fuel Cells and DuPont Taiwan, Ltd. recently announced they have signed "definitive agreements" with Asia Pacific Fuel Cell Technologies (APFCT) to collaborate on an effort to "commercialize proton exchange membrane (PEM) fuel cells for the Taiwan scooter market." For more information: http://www.apfct.com
Astris Energi, Inc.	Model E6	In development			Used in world's first alkaline fuel cell powered golf card (below)	
Astris Energi, Inc.	Fuel Cell Golf Cart	Available				Project completed in March 2001. Powered by a hybrid power plant - Model E6 and a battery serving as a starter battery and energy storage - peaking device. Max. Speed is 25 mph (40 kph) b/c of governing chip, but the cart is capable of much higher speeds.
Ballard Power Systems	Mark 902 Fuel Cell Module	Available (2001)	N/A		The Mark 902 proton exchange membrane (PEM) fuel cell module is Ballard's fourth generation transportation fuel cell platform. Offering a continuous maximum output of 85 kilowatts, the fuel cell module was designed for integration into vehicle applications.	For additional information about current products and business activities, please visit www.ballard.com. Ballard Power Systems Inc. reserves the right to change specifications or to discontinue products at any time.
Ballard Power Systems	Xcellsis™ HY-75 Fuel Cell Engine	N/A	N/A		Ballard has developed a lightweight fuel cell engine that offers automotive manufacturers the opportunity to develop their own clean fuel cell vehicles. When compared with a conventional internal combustion engine, the fuel cell engine is cleaner, quieter, and significantly more energy efficient. The compact engine is designed to fit beneath the floor of the vehicle without reducing the size of the passenger compartment and is packaged for easy integration into a wide range of vehicle platforms, from large sport utility vehicles (SUVs) to compact cars.	For additional information about current products and business activities, please visit www.ballard.com. Ballard Power Systems Inc. reserves the right to change specifications or to discontinue products at any time.
Ballard Power Systems	Xcellsis™ ME-75 Fuel Cell Engine	N/A	N/A		Ballard is developing fuel-processing systems that will allow its light-duty engines to utilize not only hydrogen but also fuels such as methanol and gasoline and other fuels. This will provide Ballard customers with the maximum amount of flexibility when it comes to fuel choice. The Xcellsis™ ME-75 fuel cell engine is a	For additional information about current products and business activities, please visit www.ballard.com. Ballard Power Systems Inc. reserves the right to change specifications or to discontinue products at any time.

					complete power solution and has been designed for simple installation into a range of vehicular platforms. The engine is fueled by methanol and includes an onboard reformer allowing operational ranges similar to those of conventional vehicles. Pressure-free storage of the liquid methanol in the vehicle makes handling easy. The modular design allows the engine to be easily adapted to different applications.	
Ballard Power Systems	Xcellsis™ HY-205 Fuel Cell Engine	N/A	N/A		Ballard is developing and manufacturing hydrogen-fueled heavy-duty engines for transit bus applications. Third-generation heavy-duty engines have been demonstrated in real-world transit bus demonstration programs in Chicago, Illinois and Vancouver, British Columbia and a fourth-generation engine was demonstrated in bus operations in Thousand Palms, California. Next-Generation Phase 5 engines will be delivered for use in Citaro buses in 10 cities in Western Europe beginning in 2002. This series of fuel cell engines provides power to the heavy-duty vehicle using a conventional automatic transmission, through a conventional rear axle. The drive train provides excellent hill climbing capability and allows for high road speed. It is suitable for applications requiring a simple, low cost and rugged solution, using as many proven transportation industry components as possible. Customers with diesel or natural gas fleets will be able to use many of their existing auxiliary components, simplifying maintenance and spare parts supply.	For additional information about current products and business activities, please visit www.ballard.com. Ballard Power Systems Inc. reserves the right to change specifications or to discontinue products at any time.
Ballard Power Systems	Nexa™ Module	Available for OEMs	N/a		Uses BALLARD's Nexa™ module with HERA hydride canisters. Scheduled for debut at 2002's Commonwealth Games in Manchester.	Green Heart Millennium Transport have been working on an inner city 2 seated (plus driver) electric vehicle for some 5 years. The vehicle inspired by the need for tourist transport in enclosed environments such as the docklands is similar in style to the auto rickshaw. This vehicles is suitable for a range duties and has delivery vehicle variants.
Delphi Automotive Systems / BMW / Renault	Fuel Cell Auxiliary Power Unit	Within next five years (2005 – 6)			Benefits: No need for CO cleanup in the reformatting process; No humidification or reactants necessary; no water management system required; can operate at maximum efficiency whether the engine is on or off; current trials suggest savings of $1000/year in burned fuel during idling for the average heavy-duty diesel truck; and it will not draw power from the vehicle's battery.	Delphi will develop the gasoline and diesel fuel cell system, and BMW and Renault will integrate the system into their respective vehicles within the next five years.
Fuel Cell Technologies LTD	Portable APU	Planned future program				High-efficiency diesel/gas fuelled auxiliary power unit for transportation industry
Fuel Cell Technologies LTD	ALTEX AUV Power module	In development				FCT develops customized power systems for autonomous underwater vehicles (AUVs) and underwater exploration stations. These systems are built to meet specific customer requirements and can be designed to provide power ranging from a nominal 50 W to 5 kW. The air independent Aluminum Oxygen Semi-Fuel Cell provides energy endurance levels 3 times greater than silver zinc battery systems, 6 to 7 times greater than NiCd batteries, and 10 times greater than lead acid batteries. This high endurance feature greatly increases the operating range and endurance of AUVs or the operating endurance of exploration stations before the power source requires refueling. This can greatly reduce labor times and surface ship requirements on scientific missions, thereby reducing

						mission costs. Refuel time = 2 hours.
Fuel Cell Technologies LTD	ARCS 4 AUV Power module	In development				Refuel time = 2 hours
Fuel Cell Technologies LTD	DH	In Development				For underwater applications
General Motors	GM 2001 Automotive Fuel Cell Stack	In Testing (see fuel cell vehicle chart for GM FCVs)	N/a		3000 hours complete w/ 6000 hours the target	1.75 kW/l (1.25 kW/kg) and zero humidification; for automotive, stationary & industrial applications
Hydrogenics, Inc.	HyPEM –LP2 Module 3rd Generation	In Testing	N/a			Will be Incorporated into a John Deere vehicle as well as a New Flyer fuel cell hybrid bus (2005) in Canada. This bus will use a distributed array of fuel cell power modules rather than on large power module in the rear. It will also use Hydrogenics' proprietary vehicle-to-grid technology.
Manhattan Scientifics, Inc.	NovArs Mid-Range Fuel Cell	In testing				For more information: http://www.mhtx.com
Manhattan Scientifics, Inc. / Aprilia	Fuel Cell Bicycle	In testing				Received TIME magazine's 2001 invention of the year award. For more information: http://www.apriliaenjoy.com
Manhattan Scientifics, Inc. / Aprilia	Fuel Cell Scooter	In testing				Latest prototype completed in 2002.
Nuvera	PEM fuel cell	In testing			Used in Fiat's fuel cell prototypes and several fuel cell bus projects – see other charts	
Palcan	PEM fuel cell stack	In testing				Palcan is already selling fuel cell and hydrogen storage devices for laboratory and product demonstration purposes. Moving forward from existing demonstration systems, the proposed product development sequence (subject to change from market and joint venture opportunities) is as follows: • Electric bike systems (300 W to 1 kW) • Electric Vehicle Power for scooters, and 3 & 4 wheel vehicles (1 to 5 kW) • Portable and backup power (including DC to AC inverters) • Metal Hydride products for hydrogen storage and purification • Auxiliary Power as backup to main engine on trucks and recreational vehicles
Palcan	Fuel Cell Bike	In testing				A Celco electric scooter is presently being retrofitted at Palcan's development facility (left). For more information: http://www.palcan.com
Paul Sherrer Institute (PSI)	PEM stacks	In Testing			Used by VW in their HyPOWER Fuel Cell Vehicle prototype – see fuel cell vehicle chart Used in fuel cell boat prototype below: 	The Fuel Cell Group at PSI, a collaborative effort of electrochemists, polymer chemists, physicists, material scientists, and mechanical engineers, was established in 1990 as part of the PSI Electrochemistry Section. Since then, The Fuel Cell Group at PSI has been active in various international (International Energy Agency, European Community, Industry) and national projects (Swiss Federal Office of Energy, Swiss Federal Office of Science and Education, Industry) in the area of polymer electrolyte fuel cell (PEFC) research. Currently, activities concerning Material and Structural Research Aspects of PEFC in the research domains

PowerZinc Electric Inc.	DQFC-24-3000	In Testing Phase	US$106 /kWh	 the New DQFC series	Taipei, Taiwan Shanghai, China Shenzhen, China Sacramento, California	This is being used in their fuel cell powered scooter and is being looked at to power EV's and many other scalable applications For more information: www.powerzinc.com
PowerZinc Electric Inc.	Scooter prototype	In testing				For more information: www.powerzinc.com
Proton Motor GmbH	G-Series	In testing			Involved with NovaBus and Neoplan fuel cell bus demonstrations – see the fuel cell bus chart	Air-cooled, low pressure operation For more information: http://www.proton-motor.de/protonenglisch/index2.html
Proton Motor GmbH	H-Series	In testing			Involved with NovaBus and Neoplan fuel cell bus demonstrations – see the Fuel Cell Bus Chart	Liquid-cooled, low pressure operation For more information: http://www.proton-motor.de/protonenglisch/index2.html
Schatz Energy Research Center (SERC)	Neighborhood vehicle	In use at Schatz Hydrogen Center			Part of the Palm Desert Renewable Hydrogen Transportation Project – see H2 Fueling Station Chart	Fuel cell stack was designed, fabricated and assembled in-house by Schatz engineers and technicians.
Schatz Energy Research Center (SERC)	Golf Cart	Testing			Part of the Palm Desert Renewable Hydrogen Transportation Project – see H2 Fueling Station Chart	Fuel cell stack was designed, fabricated and assembled in-house by Schatz engineers and technicians.
Siemens	Fuel Cell Bus System	Testing			Used in several fuel cell bus projects – see Fuel Cell Bus Chart	
Toyota	Fuel cell stack for use in their FCV	Testing			Used in Toyota fuel cell prototypes – see Fuel Cell Vehicle Chart	Already exceeds the DOE's 2004 target of 1 kW of energy per liter of volume
UTC Fuel Cells	Fuel Cell APU	Testing			Currently used by BMW in their Munich Airport fleet	
UTC Fuel Cells	Series 300 ambient pressure fuel cell	Testing			Installed in Hyundai's fuel cell prototype – see Fuel Cell Vehicle Chart Also used in several fuel cell buses prototypes – see Fuel Cell Bus Chart	Has development agreements with the Nissan/Renault partnership In 2000, UTC Fuel Cells signed separate development and demonstration partnership agreements with Thor Industries, the largest maker of mid-size buses in the United States, and Irisbus, one of the largest European maker of buses
UTC Fuel Cells	Space Program Fuel Cell	Available (NASA)			These stacks have flown over 108 missions, and logged over 84,963 operating hours	Electrical power for NASA's Space Shuttle Orbiter is provided by fuel cell power plants designed, developed, and built by UTC Fuel Cells. In the Orbiter, a complement of three 12kW fuel cells produces all onboard electrical power; there are no backup batteries, and a single fuel cell is sufficient to insure safe vehicle return. In addition, the water produced by the electrochemical reaction is used for crew drinking and spacecraft cooling.

Notice: For additional information or comments on Fuel Cells 2000's charts, contact Brian Walsh at: brian@fuelcells.org.