Industries
Energy

New Energy for World Markets*

2006 Fuel Cell Industry Survey
A Survey of 2005 Financial Results of Public Fuel Cell Companies



METHODOLOGY

The financial data presented in this survey is principally based on information published in the annual reports of publicly traded fuel cell companies (the PwC Fuel Cell List) for the fiscal year ending in 2005. The discussion that accompanies the financial data is also based on publicly available information and is intended to provide an overview of the activities of the PwC Fuel Cell List—it is not intended to be comprehensive.

Companies were included in the survey if: (a) their primary goal is fuel cell production and/or system integration and/or related fueling infrastructure; and (b) they were a stand-alone public company as at December 31, 2005.

It is estimated that public companies represent less than one third of the fuel cell industry. Readers should note that considerable activity in this sector is conducted by private companies and operating divisions or subsidiaries of larger, diversified organizations, including MTI Micro Fuel Cells, Rolls Royce Fuel Cells and UTC Fuel Cells.

All figures are expressed in US dollars.

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2006 Fuel Cell Industry Survey
A Survey of 2005 Financial Results of Public Fuel Cell Companies

Welcome to the PricewaterhouseCoopers 2006 Fuel Cell Industry Survey. Published annually, this survey provides the industry and the public with a perspective on the financial performance and activities of publicly traded companies in the sector as they develop.

This year, the survey reviews 23 public companies spanning the complete fuel cell supply chain from fuels to components to stacks to integration, in all fuel cell markets; infrastructure, portable, mobile, and stationary.

During 2005, Stuart Energy, a generator of hydrogen through alkaline electrolysis, was acquired by Hydrogenics. Consequently, Stuart Energy does not appear in this year's survey.

In 2005, four companies, focused in whole or in part on portable fuel cell markets, became listed on the London Stock Exchange Alternative Investment Market, raising a total of $61 million during their initial public offerings. They are included in the PwC Fuel Cell List for the first time.

- Acta SpA (Italy)—a developer and manufacturer of low-cost, platinum-free catalysts.
- CMR Fuel Cells (UK)—a developer of mixed-reactant, flow-through, direct methanol fuel cell stacks.
- PolyFuel (USA)—a developer of hydrocarbon-based membranes for use with direct methanol fuel cells.
- Voller Energy (UK)—a developer and manufacturer of fuel processors that generate hydrogen from propane or diesel fuel, and a PEM fuel cell system integrator.

Since our last survey, the industry continued to improve fuel cell technologies, reduce operational costs, identify near-term revenue opportunities, and secure strategic alliances in key markets around the world.

The industry metrics reported by this survey show a number of interesting changes from the previous year.

- A 20% increase in revenues to $266 million.
- A 6% decrease in research and development (R&D) expenditures to $206 million.
- An 8% increase in employees to 3,022.
- A 5% decrease in market capitalization to $3.2 billion.

Industry overview

GEOGRAPHIC LOCATION

Of the four companies new to the PwC List for the 2005 survey year, three are European and one is from the United States. As the number of European companies on the PwC List grows, the relative proportion of North American companies falls; from 85% in 2004 to 74% in 2005.

However, this is a global industry. To facilitate access to key geographic markets or to gain closer proximity to development and distribution partners or principal customers, many companies maintain employees and operations in several countries around the world.

- Ballard is a Canadian company with operations in the United States, and a joint venture, EBARA Ballard, in Japan.
- Hydrogenics is a Canadian company with operations worldwide including the United States, Japan, Germany, and an on-site hydrogen generation group in Belgium.
- Astris Energi is a Canadian company with a wholly owned subsidiary, Astris sro, in the Czech Republic.
- Medis is based in the United States with research and development operations in Israel.
- Ceramic Fuel Cells is an Australian company, listed in the UK, and establishing operations in Europe.

TECHNICAL FOCUS

While activity continues in all fuel cell and hydrogen technologies, 2005 saw a marked increase in the number of companies focused on portable markets. All companies new to the PwC Fuel Cell List are developing technologies and components of fuel cell systems intended to either replace or charge batteries used in portable electronic devices, specifically, for use with direct methanol and direct liquid fuel cells.

FIGURE 1. NUMBER OF COMPANIES IN THE PwC FUEL CELL LIST

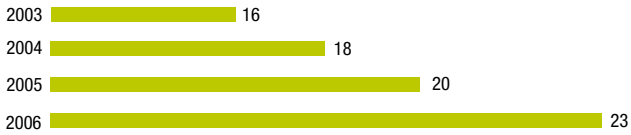


FIGURE 2. GEOGRAPHIC LOCATION OF THE PwC FUEL CELL LIST

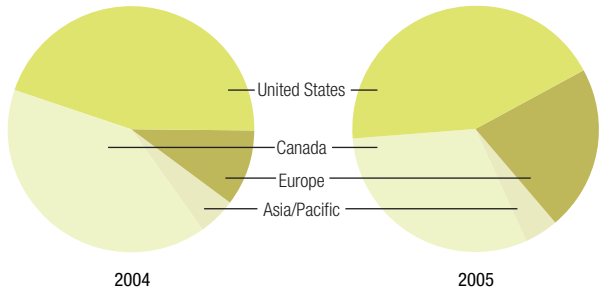
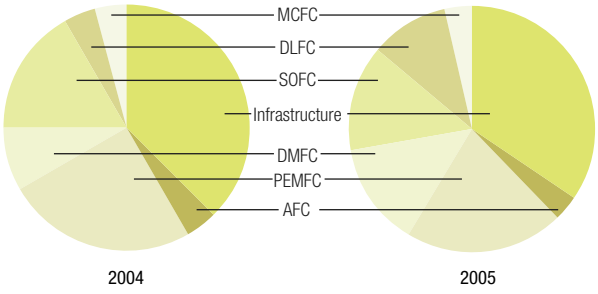


FIGURE 3. FOCUS AREAS OF THE PwC FUEL CELL LIST



Fuel Cell Technologies

Alkaline Fuel Cells (AFC) have been used in the US space program since the 1960s and are currently being developed for use in stationary, portable and mobile markets.

Direct Liquid Fuel Cells (DLFC), including those using liquid alcohol fuels such as ethanol, are primarily battery replacements for portable electronic devices.

Direct Methanol Fuel Cells (DMFC) are being developed for portable and micro applications such as laptop computers and mobile phones.

Infrastructure (INF) refers to activities related to the hydrogen supply chain, including the creation, storage and distribution of hydrogen.

Molten Carbonate Fuel Cells (MCFC) are best suited for larger stationary applications.

Proton Exchange Membrane Fuel Cells (PEMFC) are the leading fuel cell technology for use in transportation applications.

Solid Oxide Fuel Cells (SOFC) may be used in both utility and small-scale stationary power systems.

Companies focused on specific components such as catalyst, electrodes and membranes are categorized under the fuel cell type to which their technology is most closely aligned.

While public companies represent only a portion of the industry, the reporting requirements of these businesses allow insight into the operational, financial and strategic realities facing the industry as a whole.

PwC Fuel Cell List

TABLE 1. COMPANY FINANCIAL INFORMATION ($ THOUSANDS)[1]

Company Name	Location	Focus Area	Gross Revenues[2]		Net Loss		R&D Expenditures[3]		Total Assets		Net Cash Flow		Market Capitalization[4]	
			2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004
Quantum Fuel Systems	USA	INF	54,300	28,119	(13,099)	(8,934)	17,176	13,998	277,662	103,447	(3,992)	4,190	139,038	184,886
Ballard Power Systems Inc.	Canada	PEMFC	53,733	81,373	(86,983)	(175,407)	75,492	91,737	524,874	659,171	(39,829)	(89,351)	471,295	805,320
Distributed Energy Systems	USA	INF	44,980	22,460	(16,244)	(22,437)	4,059	6,253	111,146	124,571	14,611	1,714	281,836	89,024
Hydrogenics Corp.	Canada	PEMFC/INF	37,191	16,656	(37,374)	(33,539)	7,745	9,069	214,657	117,861	(20,815)	17,564	286,957	312,794
FuelCell Energy Inc.	USA	SOFC/MCFC	30,370	31,386	(68,186)	(86,443)	21,840	26,677	265,520	236,510	(23,057)	4,759	409,711	476,467
Dynetek Industries Ltd.	Canada	INF	22,109	20,479	(2,020)	(954)	2,291	2,749	37,920	38,023	(1,098)	(4,383)	36,458	38,067
Plug Power Inc.	USA	PEMFC/INF	13,486	16,141	(51,743)	(46,739)	36,319	35,203	139,784	117,997	2,901	(69,708)	440,335	448,174
QuestAir Technologies Inc.	Canada	INF	5,145	2,266	(7,781)	(7,182)	4,688	3,546	13,964	9,940	3,043	3,163	30,729	52,625
Fuel Cell Technologies Corp.	Canada	SOFC	1,140	813	(3,903)	(3,013)	1,663	1,782	2,862	5,463	(2,929)	(2,609)	0	19,516
PolyFuel Inc.	USA	DMFC	1,040	358	(7,943)	(8,967)	5,344	4,684	15,564	12,745	6,331	5,872	39,811	0
Ceramic Fuel Cells Ltd	Australia	SOFC	737	254	(12,978)	(11,111)	8,969	7,261	7,406	18,420	(12,005)	9,123	38,924	84,245
Medis Technologies Ltd.	USA	DLFC	425	0	(18,550)	(15,662)	12,144	9,799	120,400	79,773	19,537	9,138	411,475	495,759
Millennium Cell Inc.	USA	PEMFC	417	198	(14,600)	(10,805)	610	475	15,034	13,306	3,458	2,214	60,855	50,066
Astris Energi Inc.	Canada	AFC	241	68	(4,404)	(2,666)	752	1,035	843	423	(124)	(130)	4,227	7,871
Ceres Power Holdings plc	UK	SOFC	132	0	(4,923)	(2,892)	4,316	2,532	31,123	8,770	2,327	54	135,406	126,693
Palcan Power Systems	Canada	PEMFC/INF	107	114	(819)	(1,479)	470	644	211	355	(68)	32	1,766	2,920
Voller Energy Group plc	UK	INF	78	14	(1,508)	(240)	0	0	15,795	493	15,209	357	15,811	0
Pacific Fuel Cell Corp.	USA	PEMFC/DMFC	52	114	(521)	(587)	122	57	320	952	(479)	633	21,337	20,608
Acta SpA	Italy	INF/DLFC	14	0	(3,934)	(474)	223	50	16,293	1,731	13,918	175	76,394	0
Alternate Energy Corp.	USA	INF	0	0	(4,017)	(7,312)	108	31	849	3,822	(282)	7	9,923	39,830
CMR Fuel Cells plc	UK	DMFC	0	0	(972)	(246)	0	0	21,885	320	696	290	45,076	0
ITM Power plc	UK	DLFC	0	0	(2,233)	(1,019)	1,723	993	16,452	961	515	(147)	246,572	121,901
Manhattan Scientifics Inc.	USA	DMFC	0	150	(219)	(1,517)	227	333	1,170	1,303	248	60	10,478	11,236
Total			265,697	220,963	(364,954)	(449,625)	206,281	218,908	1,851,734	1,556,357	(20,117)	(106,984)	3,214,414	3,388,002

1. Financial data have been converted to US dollars using year end and year end average rates of exchange, where applicable. All companies have December 31 year ends except those listed below:
   - Ceramic Fuel Cells Ltd ..... June 30, 2005
   - Ceres Fuel Cells Ltd. ..... June 30, 2005
   - FuelCell Energy Inc. ..... October 31, 2005
   - ITM Power plc. ..... April 30, 2005
   - Quantum Fuel Systems ..... April 30, 2005
   - QuestAir Technologies Inc. ..... September 30, 2005
   - Voller Energy Group plc. ..... June 30, 2005
2. Revenues reported are total revenue as stated in the companies' financial statements and do not include investment or other income.
3. R&D expenditures are net and exclude costs of R&D contracts.
4. Based on the number of common shares outstanding and share prices at calendar year end.

With 2005 revenues of over $54 million, Quantum Fuel Systems takes over as lead revenue producer.

Revenue

REVENUE GENERATION

The trend towards increasing year-over-year revenue growth resumed in 2005 with revenues from companies on the PwC Fuel Cell List reaching a record high of $266 million in 2005; a 20% increase from $221 million in 2004.

Virtually all revenues were generated by North American companies. Revenues from US-based companies grew by 47% from $99 million in 2004 to $145 million in 2005. Total revenue from Canadian companies fell $2 million in 2005 to $120 million.

Outside North America, Ceramic, Ceres, Voller and Acta reported revenues totalling just under $1 million.

Revenues reported were from the sales of products and services into the mobile, stationary and infrastructure markets. With the exception of PolyFuel, no significant revenues were achieved in the portable markets, despite the generally accepted belief that these markets are the nearest to commercialization.

Many of the development stage companies included in this survey have yet to report any revenues at all.

Increases

- Quantum tops the List this year with revenue of $54 million, up 93% from $28 million in 2004. Of this total, newly acquired Tecstar accounted for $31 million, while organic growth accounted for $23 million.
- Distributed Energy's revenue doubled in 2005; from $22.5 million in 2004 to $45 million in 2005.
- In Canada, Hydrogenics' revenue grew by over 117% from $17 million in 2004 to $37 million in 2005. Much of this revenue was attributed to the acquisition of Stuart Energy, with 11% generated by organic growth.
- QuestAir's revenues doubled to $5 million.
- Revenues for Dynetek rose approximately $2 million in 2005 to $22 million.

Decreases

- Ballard Power Systems, the top Canadian revenue producer, saw a 33% reduction in revenue, from $81 million in 2004 to $54 million in 2005. Reduced revenues have been attributed to a $30 million reduction in automotive product delivery, reflecting the timing of their customers' fuel cell vehicle deployments. However, service revenues increased in 2005.
- FuelCell Energy's total revenues decreased slightly in 2005 to $30 million as a result of lower research and development revenues. Product revenues from the same period, however, rose 30%, from $13 million to $17 million.

TABLE 2. GROSS REVENUES ($ THOUSANDS)

Company	Location	2005	2004
Quantum Fuel Systems	USA	54,300	28,119
Ballard Power Systems Inc.	Canada	53,733	81,373
Distributed Energy Systems Corp.	USA	44,980	22,460
Hydrogenics Corp.	Canada	37,191	16,656
FuelCell Energy Inc.	USA	30,370	31,386
Dynetek Industries Ltd.	Canada	22,109	20,479
Plug Power Inc.	USA	13,486	16,141
QuestAir Technologies Inc.	Canada	5,145	2,266
Fuel Cell Technologies Corp.	Canada	1,140	813
PolyFuel Inc.	USA	1,040	358
Ceramic Fuel Cells Limited	Australia	737	254
Medis Technologies Ltd.	USA	425	0
Millennium Cell Inc.	USA	417	198
Astris Energi Inc.	Canada	241	68
Ceres Power Holdings plc	UK	132	0
Palcan Power Systems	Canada	107	114
Voller Energy Group plc	UK	78	14
Pacific Fuel Cell Corp.	USA	52	114
Acta SpA	Italy	14	0
Alternate Energy Corp.	USA	0	0
CMR Fuel Cells plc	UK	0	0
ITM Power plc	UK	0	0
Manhattan Scientifics Inc.	USA	0	150
Total		265,697	220,963

Markets and customers

In 2005, sales were limited. Most companies on the PwC Fuel Cell List are considered development stage companies, focusing on technological research and testing. Although these companies may generate revenue from the sale of contract research and engineering services to OEMs or governments, few have market-ready products. Of those companies reporting revenue from product sales, virtually all are selling to a limited number of early adopters, including utility and OEM partners, government-sponsored demonstration projects, and the military.

Several companies are, however, developing marketing and distribution networks, creating supply chain relationships, and building the manufacturing capabilities required to meet significant order volumes anticipated in the future.

Mobile

The mobile market includes research, development and demonstration of fuel cell and hydrogen technology for transportation applications, whether that be automobiles, boats, aircraft or trains. This pre-commercial market is supported almost exclusively through government and corporate funding, and military contracts.

- Ballard is continuing to supply fuel cells and engineering services to ongoing and newly announced demonstration programs worldwide.
- 88% of Quantum's 2005 revenue was produced through sales to General Motors and Toyota. Quantum is also supplying prototype fuel cell vehicles to the US Military.
- Early sales are being made by Ballard, Hydrogenics and others in mobile markets for forklifts, golf carts and auxiliary power units.

Stationary

Markets for stationary fuel cell technologies range from the smaller power requirements of individual homes and back-up generators, to larger megawatt industrial applications.

- Government support for ultra-clean power generation and distributed energy networks are driving growing demand for stationary applications, particularly in Europe and Japan.
- Ballard, through its joint venture partnership EBARA Ballard, is working with Tokyo Gas and Nippon Oil to pursue commercial opportunities for the co-generation of heat and power in the Japanese residential market. Hydrogenics and a number of other public fuel cell companies are also active in this market.
- Plug Power and Hydrogenics are focusing on providing back-up power generation for critical data centres and telecommunication infrastructure.
- FuelCell Energy and Distributed Energy are generating revenue from the installation and servicing of larger scale on-site power systems for industrial customers.

Portable

Portable and micro applications refer to personal use items, including battery chargers and battery replacements for use in consumer, military, medical and recreational electronics equipment. This market is widely considered the most near-term of all fuel cell markets. It is also becoming a crowded market with a number of competing technologies.

- While widespread end-user adoption into these markets was not achieved in 2005, many companies, including Medis, Millennium and Voller, are focused on refining their technologies and processes, building strategic relationships, and increasing their manufacturing capacity.
- In partnership with PEM fuel cell developer Protonex, Millennium Cell is generating revenue from the sale of hydrogen battery technology to the US military.
- PolyFuel is providing hydrocarbon-based membranes for use with direct methanol fuel cells being developed by leading consumer electronics manufacturers, including Sanyo Electric and NEC.

Infrastructure

The infrastructure market includes products, technologies and services related to the production, purification, distribution and storage of hydrogen.

- Revenue leader Quantum is involved in a broad range of infrastructure-related activities from the purification and storage of hydrogen to systems integration.
- Distributed Energy, through Proton Energy, is using PEM technology to generate hydrogen.
- Plug Power is working with Honda to develop a Home Energy Station to generate heat, electricity and hydrogen to fuel vehicles.
- Dynetek is selling high pressure gas storage cylinders for use in vehicles using liquefied natural gas and hydrogen fuel.
- Hydrogenics, through its subsidiary Hydrogenics Test Systems Inc. (formerly Greenlight Power) is developing test systems responding to needs of automotive OEMs for accelerated diagnostics.

Strategy

Other markets

Many fuel cell and hydrogen companies included in this survey are pursuing revenue opportunities beyond the industry. This approach will help address shareholder needs for a more sustainable business model, increase profitability, establish supplier and customer networks and off-set research and development costs.

- Quantum revenues include sales of engineering, manufacturing and assembly services related to specialized automotive equipment.
- Some companies, including Ballard and Alternate Energy, are marketing and generating revenue from valuable products produced in the course of developing fuel cell-related technologies.

Sales into the mature industrial market for bulk hydrogen, which includes the petroleum, pharmaceutical and food production industries, accounted for a significant amount of the reported 2005 revenue.

- Much of Hydrogenics' revenue was generated from the sale of hydrogen for industrial applications.
- Distributed Energy's revenue was generated from the sale of products and services related to distributed power and on-site hydrogen generation systems for industrial applications.
- A key market for QuestAir's hydrogen purification technology is the oil and gas refining industry.
- The majority of Dynetek's revenues are generated from the sale of cylinders and associated products for the storage and transportation of compressed natural gas and other industrial gases.

The corporate strategies of many companies are clearly stated in their annual reports. Generally speaking, these strategies could be defined as:

Focus on core strengths

Following the sale of Ballard Power Systems AG, Ballard is no longer competing with other fuel cell systems integrators and can now focus on refining stack technology and pursuing a wider market for its products, including the combined heat and power market in Japan.

Ceres will focus on its strengths in engineering and systems integration and rely on partners to supply assembly, distribution, installation and service.

Diversification

With the purchase of Stuart Energy, Hydrogenics is expanding its hydrogen production capabilities, while retaining its position in power generation and testing markets.

QuestAir and Distributed Energy are providing products and services to a broad range of customers in the traditional hydrogen and distributed power markets.

Alternate Energy is exploring markets for by-products resulting from its hydrogen production process.

Supply chain positioning

Through the development of efficient and cost effective components and technologies, Acta, PolyFuel, CMR and others are positioned to play a critical role in the emerging supply chain—building strong relationships with other developers and suppliers of fuel cells and related components.

Manufacturing

Ceramic, Medis and others are developing manufacturing technologies and capacity.

Quantum is positioning itself as a tier one supplier of engineering, manufacturing, integration and assembly services to the automotive industry.

Aligning with renewables

Alkaline electrolysis technology, being developed at Hydrogenics and ITM, is particularly suitable for the producing of hydrogen from power generated from wind or solar installations.

Strategic relationships are key to accessing markets, developing technologies and establishing the supply chain needed for volume production.

M&A ACTIVITY

We are seeing the continuation of restructuring and consolidation within the industry as companies implement their strategies.

- Hydrogenics acquired 100% ownership of Stuart Energy Systems, a leader in alkaline electrolysis technology.
- Voller Energy acquired the assets of KAT-Chem GmbH, which is a German based developer of hydrogen reformer technology.
- Ballard sold its German subsidiary, Ballard Power Systems AG, to its strategic partners, DaimlerChrysler and Ford.
- Quantum acquired Tecstar (formerly Starcraft), a tier one manufacturer of specialized, limited edition vehicles.
- The Energy Research Centre of the Netherlands sold its MCFC technology to FuelCell Energy.

COLLABORATION

Strategic alliances refer to collaborative arrangements within the industry, and to associations between fuel cell companies and customers, suppliers or marketing and distribution companies. These relationships are key to accessing markets, developing technologies and establishing the supply chain required for high volume production.

- Plug Power formed a joint venture with GE MicroGen, Inc. to form GE Fuel Cell Systems, LLC to market, sell, install and service PEM fuel cell systems.
- Millennium Cell partnered with Protonex to develop fuel cells for the US Air Force.
- Fuel Cell Technologies and Toto Ltd. of Japan signed a contract for the joint development of a SOFC system.
- Millennium Cell and Dow Chemicals will jointly develop portable fuel cells for electronics and military applications.
- Astris has signed an agreement with Plasma Environmental Technologies to install a hydrogen-producing waste processing system in automotive fuel cells to reduce waste.
- Hydrogenics has signed an agreement with Hitachi Zosen to develop hydrogen fuel cell-based power products for the Japanese market.
- Medis Technologies signed a contract with Celestica, an electronics manufacturing firm, for its liquid fuel cell Power Pack products.
- Hydrogenics has provided Purolator with the fuel cells for its hydrogen fuel cell hybrid electric vehicle. The company has also been contracted to manufacture a self-contained regenerative fuel cell power system for the US Army.
- Plug Power has signed an agreement with FDT Associates in the UK to market, distribute and sell back-up power products to telecom clients.
- QuestAir signed a three year agreement with Mitsubishi Kakoki Kaisha Ltd. to market hydrogen purification systems in Asia.
- American Power Conversion, a supplier of IT application systems, is using Hydrogenics' fuel cell technology in its products.
- ASE International ordered a total value of $50 million of Power Pack products from Medis Technologies to distribute to drug stores, convenience stores, and department stores.
- FuelCell Energy and Enbridge have made an agreement on multi-megawatt products designed for natural gas pipeline applications.

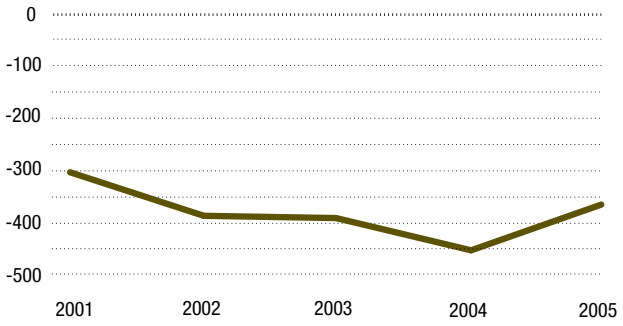
Many companies are setting milestones in performance, costing and technical achievement as part of their documented commercialization strategies.

Profitability

None of the companies included in this survey were profitable in 2005. However, with a 19% decrease in net losses, from $450 million in 2004 to $365 million in 2005, the industry reversed a four-year trend towards ever increasing year-over-year losses.

Many companies took action to limit operational and R&D spending, reduce staff, focus on near-term revenue opportunities, and continue merger and acquisition activities.

FIGURE 4. NET LOSSES ($ THOUSANDS)[5]



5. 2001 data from: *2003 Fuel Cell Industry Survey: PricewaterhouseCoopers*
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TABLE 3. NET LOSSES ($ THOUSANDS)

Company	Location	2005	2004
Quantum Fuel Systems	USA	(13,099)	(8,934)
Ballard Power Systems Inc.	Canada	(86,983)	(175,407)
Distributed Energy Systems Corp.	USA	(16,244)	(22,437)
Hydrogenics Corp.	Canada	(37,374)	(33,539)
FuelCell Energy Inc.	USA	(68,186)	(86,443)
Dynetek Industries Ltd.	Canada	(2,020)	(954)
Plug Power Inc.	USA	(51,743)	(46,739)
QuestAir Technologies Inc.	Canada	(7,781)	(7,182)
Fuel Cell Technologies Corp.	Canada	(3,903)	(3,013)
PolyFuel Inc.	USA	(7,943)	(8,967)
Ceramic Fuel Cells Limited	Australia	(12,978)	(11,111)
Medis Technologies Ltd.	USA	(18,550)	(15,662)
Millennium Cell Inc.	USA	(14,600)	(10,805)
Astris Energi Inc.	Canada	(4,404)	(2,666)
Ceres Power Holdings plc	UK	(4,923)	(2,892)
Palcan Power Systems	Canada	(819)	(1,479)
Voller Energy Group plc	UK	(1,508)	(240)
Pacific Fuel Cell Corp.	USA	(521)	(587)
Acta SpA	Italy	(3,934)	(474)
Alternate Energy Corp.	USA	(4,017)	(7,312)
CMR Fuel Cells plc	UK	(972)	(246)
ITM Power plc	UK	(2,233)	(1,019)
Manhattan Scientifics Inc.	USA	(219)	(1,517)
Total		(364,954)	(449,625)

Innovation

RESEARCH AND DEVELOPMENT

Total research and development expenditure of the PwC Fuel Cell List fell to $206 million in 2005 from $219 million in 2004. These expenses include costs incurred by a company and are separate from revenue generated from contract research services provided by the company. These research costs are often matched in part by project funding provided by government or corporate sponsors.

Relative to revenues, some companies spent considerably more on research than others:

- R&D spending by Hydrogenics and Dynetek was approximately 10% of revenue. On the other hand, in 2005 Ballard's R&D spending was 140% of revenue, leading the industry at $75 million, despite a reduction of 18% since 2004.
- Plug Power's reported R&D spending of $36 million (269% of revenue) is attributed to product development but also includes amortized expenses relating to its 2003 acquisition of H Power.
- FuelCell Energy also reported high R&D expenditures of $22 million and $27 million in 2005 and 2004, respectively.

Many companies are setting milestones in performance, costing and technical achievement as part of their documented commercialization strategies. Selected research activities and technical achievements in 2005 included:

- Ballard achieved a number of technical milestones related to freeze-start capability, durability and cost of its automotive fuel cell stacks.
- Millennium Cell demonstrated a prototype fuel cell powering an IBM ThinkPad.
- Dynetek achieved Japanese and European certification of its 10,000 psi cylinder, allowing hydrogen vehicles to travel as far as conventional vehicles.
- ITM Power is researching the use of low-cost electrolyzers.
- Pacific Fuel Cell has gained the rights to a new carbon nanotube membrane electrode assembly which could reduce the amount of platinum and, subsequently, the costs associated with PEM fuel cells.

FIGURE 5. REVENUES AND R&D EXPENDITURES ($ THOUSANDS)[6]

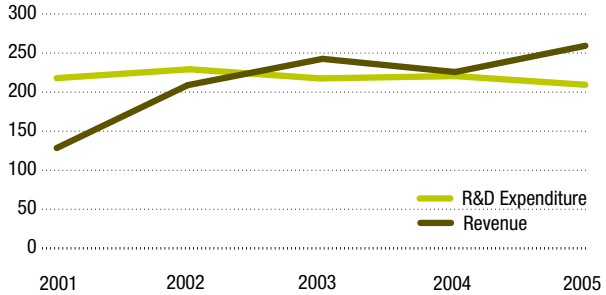

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TABLE 4. R&D EXPENDITURE ($ THOUSANDS)

Company	Location	2005	2004
Quantum Fuel Systems	USA	17,176	13,998
Ballard Power Systems Inc.	Canada	75,492	91,737
Distributed Energy Systems Corp.	USA	4,059	6,253
Hydrogenics Corp.	Canada	7,745	9,069
FuelCell Energy Inc.	USA	21,840	26,677
Dynetek Industries Ltd.	Canada	2,291	2,749
Plug Power Inc.	USA	36,319	35,203
QuestAir Technologies Inc.	Canada	4,688	3,546
Fuel Cell Technologies Corp.	Canada	1,663	1,782
PolyFuel Inc.	USA	5,344	4,684
Ceramic Fuel Cells Limited	Australia	8,969	7,261
Medis Technologies Ltd.	USA	12,144	9,799
Millennium Cell Inc.	USA	610	475
Astris Energi Inc.	Canada	752	1,035
Ceres Power Holdings plc	UK	4,316	2,532
Palcan Power Systems	Canada	470	644
Voller Energy Group plc	UK	0	0
Pacific Fuel Cell Corp.	USA	122	57
Acta SpA	Italy	223	50
Alternate Energy Corp.	USA	108	31
CMR Fuel Cells plc	UK	0	0
ITM Power plc	UK	1,723	993
Manhattan Scientifics Inc.	USA	227	333
Total		206,281	218,908

- Acta is developing a fuel cell that can operate on gasoline.
- QuestAir is working with ExxonMobil to develop an onboard hydrogen generator for use in the transportation market for applications such as auxiliary power units and utility equipment.
- Quantum reported advances in hydrogen storage, delivering light weight, high capacity tanks to Toyota and General Motors.

DEMONSTRATION PROJECTS

Demonstration projects are designed to test developmental technologies in real-world operating conditions. These are most often large, public projects involving collaboration between several companies to integrate infrastructure, power generation and end-user applications. These projects are funded through government agencies, the military, utility companies and large OEMs.

- Hydrogenics received a contract with Nordrhein-Westfalen, Germany to build a hydrogen-fuelled bus for its transport system.
- Hydrogenics and General Motors of Canada have successfully designed and operated a fuel cell-powered forklift.
- QuestAir will supply Hyundai with hydrogen purifiers to be used in a fleet of five test cars.
- Ceramic Fuel Cells is conducting field trials to test the delivery of electricity and hot water sufficient for the average home.
- FuelCell Technologies began testing its new SOFC through Siemens Westinghouse Power Corporation.
- Plug Power has entered into an agreement with Honda to develop and test a Home Energy Station.
- Fuel Cell Technologies installed Canada's first residential fuel cell system for testing and monitoring.
- Hydrogenics has partnered with Prince Edward Island Energy in Canada to work on a project to build the first wind-hydrogen powered village in PEI.
- QuestAir Technologies is to supply a hydrogen purifier for the hydrogen energy station being built in California.

Shareholder value

CASH FLOW

In 2005, total net cash flow for the companies surveyed was negative $22 million, down from negative $107 million in 2004.

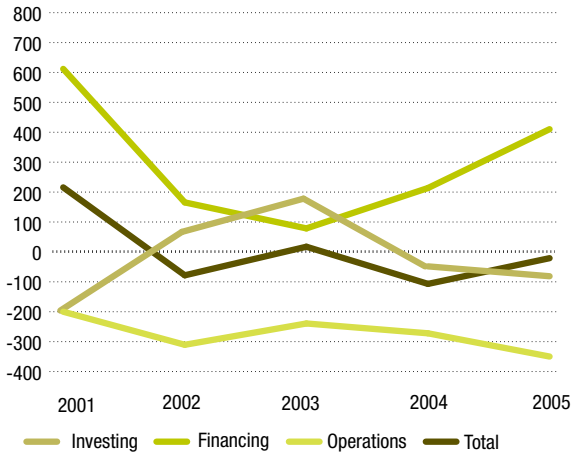
Cash flow from operations fell to negative $350 million and cash flow from investing fell to negative $81 million.

Year-over-year cash flow from financing, however, nearly doubled, rising to $409 million in 2005 from $214 million in 2004, suggesting that financing conditions were more favourable in 2005 than 2004.

TABLE 5. CASH FLOW ($ THOUSANDS)

	2005	2004
Cash Flow from Operations	(349,767)	(272,192)
Cash Flow from Investing	(81,286)	(48,371)
Cash Flow from Financing	409,166	213,578
Total Cash Flow	(21,887)	(106,985)

FIGURE 6. CASH FLOW TRENDS ($ MILLIONS)[7]



7. 2001 data from: *2003 Fuel Cell Industry Survey: PricewaterhouseCoopers*
2002 data from: *2003 Fuel Cell Industry Survey: PricewaterhouseCoopers*
2003 data from: *2004 Fuel Cell Industry Survey: PricewaterhouseCoopers*
2004 data from: *2005 Fuel Cell Industry Survey: PricewaterhouseCoopers*

New listings signal investor confidence in the commercial viability of portable fuel cell markets.

MARKET CAPITALIZATION

In 2005, total market capitalization of the industry remained virtually constant at $3.2 billion. This is consistent with the Dow Jones Industrial Average and the S&P 500 Index, which also showed little change between December 31, 2004 and December 31, 2005. However, this is well below the 22% increase posted by the S&P/TSX Composite Index, over the same period.

There is a noticeable split between companies on the List, with eight of twenty-three companies having market capitalization of over $100 million.

Ballard remained the most highly capitalized company at $471 million, despite a year-over-year 41% decline. Of the other highly capitalized companies Plug Power remained relatively steady at $440 million, FuelCell Energy fell 14% to $410 million, and Medis fell 17% to $411 million.

The initial public offerings of the four fuel cell companies on the London Stock Exchange Alternative Investment Market (AIM) exchange during 2005 raised a total of $61 million.

TABLE 6. NEW LISTINGS ($ MILLIONS)

Company	Location	Amount Raised[8]
Acta SpA	Italy	14
CMR Fuel Cells plc	UK	18
PolyFuel Inc.	USA	14
Voller Energy Group plc	UK	15
Total		**61**

8. Based on exchange rate at date of Initial Public Offering.

TABLE 7. MARKET CAPITALIZATION ($ THOUSANDS)[9]

Company	Location	2005	2004
Quantum Fuel Systems	USA	139,038	184,886
Ballard Power Systems Inc.	Canada	471,295	805,320
Distributed Energy Systems Corp.	USA	281,836	89,024
Hydrogenics Corp.	Canada	286,957	312,794
FuelCell Energy Inc.	USA	409,711	476,467
Dynetek Industries Ltd.	Canada	36,458	38,067
Plug Power Inc.	USA	440,335	448,174
QuestAir Technologies Inc.	Canada	30,729	52,625
Fuel Cell Technologies Corp.[10]	Canada	0	19,516
PolyFuel Inc.	USA	39,811	0
Ceramic Fuel Cells Limited	Australia	38,924	84,245
Medis Technologies Ltd.	USA	411,475	495,759
Millennium Cell Inc.	USA	60,855	50,066
Astris Energi Inc.	Canada	4,227	7,871
Ceres Power Holdings plc	UK	135,406	126,693
Palcan Power Systems	Canada	1,766	2,920
Voller Energy Group plc	UK	15,811	0
Pacific Fuel Cell Corp.	USA	21,337	20,608
Acta SpA	Italy	76,394	0
Alternate Energy Corp.	USA	9,923	39,830
CMR Fuel Cells plc	UK	45,076	0
ITM Power plc	UK	246,572	121,901
Manhattan Scientifics Inc.	USA	10,478	11,236
Total		**3,214,414**	**3,388,002**

9. Calculated at calendar year end.

10. Fuel Cell Technologies Corp. ceased trading in 2005.

Employment

Total full-time employment in the industry increased 8% to 3,022 from 2,791 in 2004. Many of the companies also employ contract workers.

- Following the acquisition of Stuart Energy and an organizational restructuring, Hydrogenics' total workforce was reduced by 19% of 2004 levels.
- With the acquisition of Tecstar, employment at Quantum grew 405% to 697.
- Ballard's 38% reduction in staff includes the elimination of 100 full-time positions in North America and its sale of Ballard Power Systems AG in Germany.
- Medis, has increased staff by 42% to a total of 102. In addition, Medis employs a further 19 engineers on a part time basis in Israel.

TABLE 8. EMPLOYMENT

Company	Location	2005	2004
Quantum Fuel Systems	USA	697	138
Ballard Power Systems Inc.	Canada	608	976
Distributed Energy Systems Corp.	USA	266	241
Hydrogenics Corp.	Canada	236	290
FuelCell Energy Inc.	USA	335	346
Dynetek Industries Ltd.	Canada	93	88
Plug Power Inc.	USA	309	330
QuestAir Technologies Inc.	Canada	75	74
Fuel Cell Technologies Corp.	Canada	19	26
PolyFuel Inc.	USA	33	0
Ceramic Fuel Cells Limited	Australia	105	88
Medis Technologies Ltd.	USA	102	72
Millennium Cell Inc.	USA	34	32
Astris Energi Inc.	Canada	17	18
Ceres Power Holdings plc	UK	29	21
Palcan Power Systems	Canada	9	15
Voller Energy Group plc	UK	7	3
Pacific Fuel Cell Corp.	USA	3	3
Acta SpA	Italy	9	2
Alternate Energy Corp.	USA	9	8
CMR Fuel Cells plc	UK	10	6
ITM Power plc	UK	15	12
Manhattan Scientifics Inc.	USA	2	2
Total		3,022	2,791

Perspective

The 2006 Fuel Cell Industry Survey produced some interesting results. We saw a resumption in the growth of revenues of public companies. This in itself is a positive development.

Equally interesting was the rise in revenues at Quantum Fuel Systems to supplant Ballard Power Systems Inc. at the head of the table. Underlying the rise of Quantum and the decline of Ballard are corporate transactions which saw Ballard shed some of its activities to allow greater focus on stack development, and the acquisition of a company by Quantum which enhanced its ability to supply fuel systems to fuel cell and hybrid vehicle developers.

Ballard remains the largest company in the sector in terms of assets, market capitalization and research and development. It took important steps in 2005 to tie its development efforts to a series of demanding metrics to be able to demonstrate its progress towards commercial fuel cell vehicles. It also took its first steps to building sales by securing orders for its products from two private companies in the emerging markets for fuel cell powered forklift trucks, as well as entering the Japanese residential cogeneration markets.

Other interesting developments were maintenance of significant levels of research and development expenditures which continued at over $200 million per annum. Total losses declined by approximately $85 million and market capitalization remained steady at just over $3 billion.

The emergence of Europe is also a new factor, both as a source of new public companies, but perhaps more importantly, as a venue for investment into the sector, largely through AIM.

Many companies are very small and concerned with novel approaches to the development of fuel cells or components of the supply chain. Nevertheless, they indicate a strong level of interest in the commercial potential for fuel cells to solve many pressing issues of energy supply, climate change, air quality and energy security which currently face us.

It is not surprising that many of the newer companies originate in Europe where awareness and action concerning alternatives to energy generation and distribution of fossil fuels have been more forthcoming than in North America.

We are encouraged by the general development of the sector. The unbridled optimism of the past has been replaced by a keen sense of purpose that is focused directly on producing products that can be used by customers, are competitively priced and which will produce returns for investors.

There is still much to do however, and it is important to understand that the public companies in the sector represent only a small portion of the sector. There are many more small private corporations, as well as divisions of large corporations, which are focused on various aspects of fuel cell technology.

Inevitably, because fuel cell technology development is in its early stages, some companies will fail, some companies will discontinue research programs and some companies will change course. We have seen some of this happen and there is more to come. Nevertheless, the progression of fuel cell technology, along with other competing technologies, continues. Through this and other surveys we will attempt to bring you the story as it unfolds.

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PricewaterhouseCoopers understands and supports the fuel cell industry around the world. Our Alternative Energy Network of professional staff, drawn from 130,000 people in 148 countries, has a firm grasp of the issues facing companies as the industry evolves towards commercialization.

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