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FUEL CELL TECHNOLOGIES OFFICE

2012 Fuel Cell Technologies Market Report

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Notice

Cover Photo – 400 kW Bloom Energy installation at Nokia, Sunnyvale, California

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LIST OF ACRONYMS

APU	Auxiliary Power Unit
ARB	Air Resources Board (California)
CaFCP	California Fuel Cell Partnership
CEC	California Energy Commission
CFCL	Ceramic Fuel Cells, Ltd.
CHP	Combined Heat and Power
CTE	Center for Transportation and the Environment (Georgia)
DFC	Direct FuelCell® (FuelCell Energy)
DMFC	Direct Methanol Fuel Cell
DOE	U.S. Department of Energy
FCEV	Fuel Cell Electric Vehicle
FTA	U.S. Federal Transit Administration
kW	Kilowatt
kWh	Kilowatt-hour
LOI	Letter of Intent
M&A	Merger and acquisition
MCFC	Molten Carbonate Fuel Cell
m-CHP	micro-Combined Heat and Power
MEAs	Membrane Electrode Assemblies
MOU	Memorandum of Understanding
MW	Megawatt
OTC	Over-the-Counter
PAFC	Phosphoric Acid Fuel Cell
PE	Private Equity
PEM	Proton Exchange Membrane
PIPE	Private Investment in Public Equities
SOFC	Solid Oxide Fuel Cell
SUV	Sport Utility Vehicle
VC	Venture Capital
ZEV	Zero-Emission Vehicle

INTRODUCTION

Fuel cells are electrochemical devices that combine hydrogen and oxygen to produce electricity, water, and heat. Unlike batteries, fuel cells continuously generate electricity as long as a source of fuel is supplied. Fuel cells do not burn fuel, making the process quiet, pollution-free and two to three times more efficient than combustion. A fuel cell system can be a truly zero-emission source of electricity, when the hydrogen is produced from non-polluting sources.

There are three main markets for fuel cell technology: stationary power, transportation power, and portable power. Stationary power includes any application in which the fuel cells are operated at a fixed location for primary power, backup power or combined heat and power (CHP). Transportation applications include motive power for passenger cars, buses and other fuel cell electric vehicles (FCEV), specialty vehicles, material handling equipment (e.g. forklifts), and auxiliary power units (APUs) for off-road vehicles. Portable power applications use fuel cells that are not permanently installed or fuel cells in a portable device.

In general, the trends for the fuel cell industry were encouraging in 2012. Total fuel cell shipments increased in 2012, in terms of total units and megawatts (MW). Costs continued to decline, especially for light duty vehicle applications. For example, the U.S. Department of Energy (DOE) noted that the cost per kilowatt (kW) for high volume production of transportation fuel cells moved closer to DOE's target of $30 per kW. The Carbon Trust issued a report highlighting promising U.K. efforts that, according to the report, have the potential to achieve $36 per kW.

Policies continued to be favorable for light duty vehicles. The Obama Administration doubled the fuel economy standard in the United States, California enacted the Advanced Clean Cars Program, and the U.S., Germany, Sweden, Denmark, Finland, Japan, and other countries bolstered efforts to deploy hydrogen fueling infrastructure. There were several collaboration announcements between automakers with regards to fuel cell electric vehicles, including Toyota and BMW's long-term strategic collaboration to jointly develop a fuel cell system, and Daimler,

Notable in 2012

Total fuel cell shipments increased 34 percent over 2011 and 321 percent over 2008.

Roughly 30,000 fuel cell systems were shipped in 2012, up from around 5,000 shipments in 2008, largely due to Japan's residential fuel cell program.

The number of megawatts shipped on an annual basis more than doubled between 2008 and 2012, rising from about 60 MW to more than 120 MW.

Nearly 80 percent of total investment in the fuel cell industry was made in U.S. companies in 2012.

The Obama Administration implemented new incentives for fuel cell and other advanced technology vehicles when it raised the fuel economy standard in the U.S. to 54.5 mpg for cars and light-duty trucks.

California enacted the Advanced Clean Cars Program, which is expected to significantly increase sales of zero-emission vehicles, including fuel cell electric vehicles, between 2018 and 2025, when the program will be reviewed.

A new report projects that, by 2030, the United Kingdom will have 1.6 million FCEVs on the road, with annual sales of 300,000 FCEVs in the U.K. alone.

The German Ministry of Transport announced its intention to build 35 new hydrogen fueling stations, increasing the total number of stations to 50 by 2015.

Ford, and Nissan joining forces to jointly develop a common fuel cell system and launch commercial FCEVs as early as 2017.

Dr. Steven Chu met in January 2012 with global auto makers to discuss advanced vehicle technologies and fuels. The meeting proved to be the stimulus for the formation of H_2USA, a public-private effort to advance FCEVs in the U.S.; Dr. Chu signed the agreement a few months before leaving office early in 2013. Dr. Chu also launched an expert panel on hydrogen production meeting led by the DOE's Federal Advisory Committee, the Hydrogen and Fuel Cell Technologies Advisory Committee.[1] In his remarks, Dr. Chu linked fuel cells to the increasing availability of natural gas and noted the emerging interest in hydrogen as an enabler for renewable energy generation.

In the stationary market, Bloom Energy announced that it was doubling the number of Bloom Energy Server installations and company revenue every six months. FuelCell Energy's chief executive officer stated that the company was approaching profitability, perhaps as early as 2013. Markets for applications such as telecommunications and remote sensing continued to grow.

There also was a significant amount of merger and acquisition activity in the industry, suggesting that investors see opportunities in fuel cells. United Technologies announced that it intended to sell UTC Power, its fuel cell unit. A sale was completed in 2013 to ClearEdge Power. Rolls Royce sold a majority share of its fuel cell business to South Korean conglomerate LG. Ballard Power Systems acquired IdaTech's fuel cell system business. FuelCell Energy completed its acquisition of Versa Power Systems, shoring up its move into solid oxide fuel cells, and AFC Energy acquired the assets of Diverse Energy, a U.K.-based company developing backup fuel cell systems for the Africa market. It is likely that additional merger and acquisition activity will occur in 2013.

In short, 2012 was an important and pivotal year for the fuel cell industry. Sales and shipments generally were up, markets continued to develop, new strategic alliances were formed, and policies and supporting programs continued to be implemented that tend to favor the industry.

[1] http://www.hydrogen.energy.gov/advisory_htac.html

FINANCIAL DATA

Most fuel cell companies continued to operate with significant, though in some cases, declining losses. Some fuel cell companies, however, appeared to be on the path to profitability. Bloom Energy, for example, announced in 2012 that it was doubling the number of installations and revenue every six months, and that a combination of sales growth and cost reduction was leading toward profitability. It was reported that as of 2012, Bloom had raised over $800 million since inception.

Similarly, FuelCell Energy's Chief Executive Officer, Chip Bottone, expressed optimism that the company was approaching profitability, perhaps in 2013. In 2012, FuelCell Energy had an annual production rate of 52 MW and a manufacturing capacity of up to 90 MW, and the company stated that it expected positive cash flows and net income profitability at an annual production rate of 80–90 MW. Also in 2012, FuelCell Energy strengthened its strategic relationship with South Korea's POSCO Power, entered into new strategic relationships, such as with Abengoa SA of Spain and Germany's Fraunhofer IKTS, and took other steps that it hopes will increase volume.

This section provides information regarding fuel cell cost reduction as well as revenues, cost of revenue, and other key data for selected publicly traded fuel cell companies that have fuel cells as their primary business. The focus is on public companies because many private companies do not release financial information. Finally, this section discusses venture capital, private equity, and other investment activity within the industry.

Cost Reduction

Fuel cell costs continue to decline significantly for light duty vehicles, with projected volume costs lower by more than 80 percent since 2002 and more than 35 percent since 2008, according to the DOE.[2] As shown in Figure 1, the projected cost of a transportation fuel cell system was at $47 per kW in 2012 and continues to approach DOE's target of $30 per kW. Platinum group metal content has been reduced by a factor of five and is currently at less than 0.2g per kW, with a DOE target of 0.125g per kW.[3] Fuel cell durability has more than doubled[4] and the cost of electrolyzer stacks has been reduced by 60 percent since 2007[5].

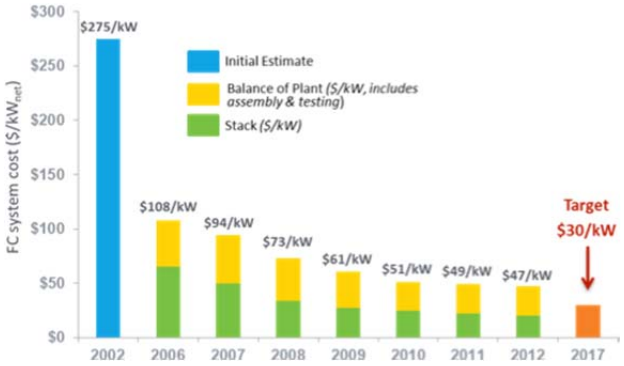

Figure 1: Projected Fuel Cell Transportation System Costs per kW, Assuming High Volume Production (500,000 units per year). Source: DOE

Significant cost reductions also were achieved by industry. Plug Power announced that the production costs for its fuel cells (ranging from 1.8 kW-10 kW) fell from $18,000 in 2008 to between $10,000 and $11,000 in 2012.[6] Nissan unveiled the TeRRA, a fuel cell sport utility

[2] http://www.hydrogen.energy.gov/pdfs/12020_fuel_cell_system_cost_2012.pdf
[3] http://www.hydrogen.energy.gov/pdfs/review12/fc001_debe_2012_o.pdf
[4] http://www.hydrogen.energy.gov/pdfs/11003_fuel_cell_stack_durability.pdf
[5] http://www.hydrogen.energy.gov/pdfs/review11/pd030_hamdan_2011_o.pdf and http://www.hydrogen.energy.gov/pdfs/review11/pd071_ayers_2011_o.pdf

vehicle (SUV) with a fuel cell that costs one-sixth as much as a Nissan fuel cell in 2005, primarily because of a significant reduction in the need for precious metals.

The Carbon Trust, a U.K.-based consultancy, issued a report on its Polymer Fuel Cells Challenge,[7] which was established in 2009 to achieve cost reductions in proton exchange membrane (PEM) fuel cells for light duty vehicles. The report estimated that PEM fuel cells for automotive applications currently cost $49 per kW, if produced in large volumes, and need to achieve $36 per kW to be competitive with internal combustion engines. The report highlighted three U.K. companies that have developed technologies that are moving from feasibility testing to commercialization and that have the potential to achieve the $36 per kW price target:

- ITM Power, which has developed a membrane that can roughly double power density, and thus increase the amount of electricity produced per unit of platinum;
- ACAL Energy, which has developed a liquid cathode that can reduce platinum use by two-thirds and eliminate the need for many fuel cell components; and
- Imperial College London and University College London, which have developed a stackable cell architecture that uses low cost materials and manufacturing techniques.

Revenues, Assets, and R&D Expenses

Fuel cell companies derive revenue from the sale of fuel cells and related equipment (such as hydrogen generators), support and maintenance contracts, and from contract research and development. In 2012, the fuel cell and hydrogen energy industry was expected to produce $785 million in revenue, according to Pike Research.[8]

Tables 1 through 3 provide financial data for select public companies. These companies were selected because fuel cells are their primary product, and because they are traded on major stock exchanges.

Table 1: Gross Revenues and Cost of Revenue for Select Public Fuel Cell Companies
(Thousands USD except where noted) (Source: Yahoo Finance)

	2012		2011		2010	
North American Companies	**Gross Revenues**	**Cost of Revenue**	**Gross Revenues**	**Cost of Revenue**	**Gross Revenues**	**Cost of Revenue**
Ballard Power Systems	43,690	36,321	55,773	48,494	65,019	54,887
FuelCell Energy [1]	120,603	120,158	122,570	135,180	69,777	88,430
Hydrogenics Corp.	31,806	26,561	23,832	18,344	20,930	15,504
Plug Power	26,108	40,463	27,626	36,902	19,473	29,482
Other Companies						
Ceramic Fuel Cells Ltd [2,3]	6,717	27,228	3,681	29,142	2,033	21,940
Ceres Power [2,4]	226	18,840	692	17,702	786	14,543
SFC Energy AG [5]	31,260	18,497	15,425	10,056	13,330	9,288

[1] Year ends October 31 [2] Year ends June 30 [3] $AUS Thousands [4] £ Thousands [5] € Thousands

[6] *Fuel Cell Market Grows With An Assist From Cheap Natural Gas*, Greenwire (2012), available at http://www.plugpower.com/News/CompanyNews/12-09-21/Fuel_cell_market_grows_with_an_assist_from_cheap_natural_gas.aspx
[7] http://www.carbontrust.com/media/195742/pfcc-cost-reduction-and-market-potential.pdf
[8] *The Fuel Cell and Hydrogen Industries: Ten Trends to Watch in 2012 and Beyond*, Pike Research (2012), available at http://www.abve.org.br/downloads/FC10T-12-Pike-Research.pdf

Table 2: R&D Expenditures for Select Public Fuel Cell Companies (Thousands USD, unless footnoted) (Source: Yahoo Finance)			
North American Companies	**2012**	**2011**	**2010**
Ballard Power Systems	19,273	24,896	28,749
FuelCell Energy [1]	14,354	16,768	18,562
Hydrogenics Corp.	4,606	2,934	3,445
Plug Power	5,434	5,656	12,901
Other Companies			
Ceramic Fuel Cells Ltd [2, 3]	11,539	15,127	10,257
Ceres Power [2, 4]	13,205	12,869	9,907
SFC Energy AG [5]	4,257	2,537	1,891
[1] Period ending October 31 [2] Period ending June 30 [3] $AUS Thousands [4] £ Thousands [5] € Thousands			

Table 3: Total Assets and Liabilities for Select Public Fuel Cell Companies (Thousands USD, unless footnoted)						
	2012		**2011**		**2010**	
North American Companies	**Assets**	**Liabilities**	**Assets**	**Liabilities**	**Assets**	**Liabilities**
Ballard Power Systems	127,547	65,135	165,290	69,970	190,027	60,031
FuelCell Energy [1]	191,485	117,119	183,630	137,224	150,529	65,473
Hydrogenics Corp.	42,088	37,856	31,061	20,288	31,473	16,037
Plug Power	39,460	24,430	55,656	26,620	59,177	16,264
Other Companies						
Ceramic Fuel Cells Ltd [2, 3]	32,810	11,913	42,785	9,250	33,275	7,229
Ceres Power [2, 4]	13,168	4,487	33,873	6,465	47,054	6,437
SFC Energy AG [5]	47,617	11,224	48,782	11,994	46,312	4,591
[1] Period ending October 31 [2] Period ending June 30 [3] $AUS Thousands [4] £ Thousands [5] € Thousands						

The data for 2012 do not reveal any clear trends. Gross revenues and cost of revenues of publicly traded fuel cell companies were mixed as compared to 2011, with some increasing and some decreasing (Table 1). For example, Ballard Power Systems showed a significant decline in both gross revenues and cost of revenues, while Hydrogenics posted significant increases. Ceres Power suffered the most significant decline in revenues - roughly 67 percent - as a result of the number of its revenue-generating customers declining from three in 2011 to one in 2012.

Four of the seven highlighted companies reduced R&D expenditures, while three companies increased R&D spending (Table 2). Ballard Power Systems and Ceramic Fuel Cells posted the most significant reductions, while Hydrogenics increased R&D expenses by roughly 57 percent. Five of the seven highlighted companies showed decreasing assets between 2011 and 2012 but five companies also showed decreasing liabilities(Table 3).

Venture Capital and Private Equity

Cumulative global investment in fuel cell companies totaled $853.6 million between 2010 and 2012. This is a significant increase over the $671.4 million invested in fuel cell companies between 2009 and 2011, as reported in last year's edition of this report. This likely reflects the improvement in the economy since the end of the recession that began in 2008.[9] Figure 2 provides a breakdown by quarter and by investment type.

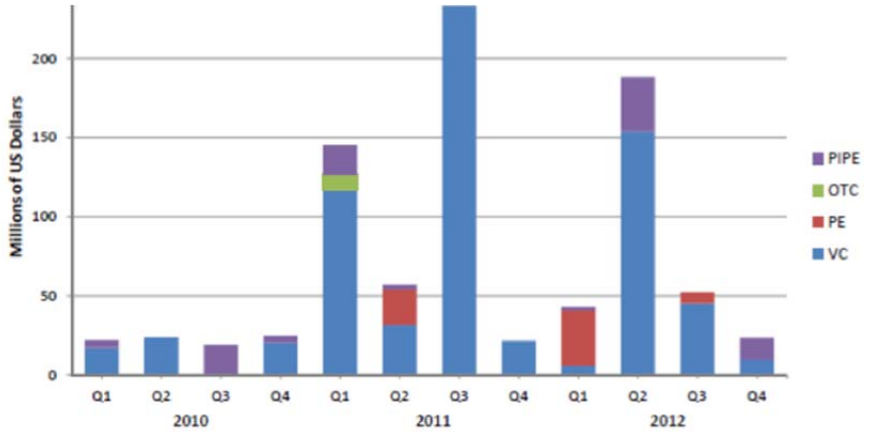

Figure 2: Worldwide Venture Capital (VC), Private Equity (PE), Over-the-Counter (OTC), and Private Investment in Public Equities (PIPE) Investments in Fuel Cell Companies (2010 – 2012) Source: Breakthrough Technologies Institute using data from Bloomberg New Energy Finance

Total investment in fuel cell companies in 2012 was $307.1 million, down from $457.2 million in 2011. Much of this difference, however, can be explained by $233.4[10] million in fuel cell venture capital investment recorded in the third quarter of 2011, which was by far the largest amount of money invested in fuel cells in any single quarter between 2006 and 2011.

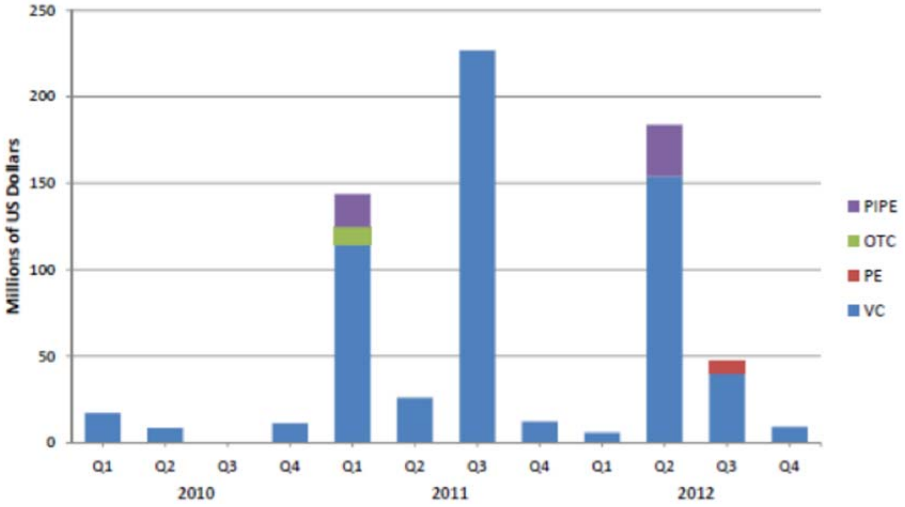

Figure 3: U.S. Venture Capital (VC), Private Equity (PE), Over-the-Counter (OTC), and Private Investment in Public Equities (PIPE) Investments in Fuel Cell Companies (2010 – 2012) Source: Breakthrough Technologies Institute using data from Bloomberg New Energy Finance

Total venture capital investment in fuel cells was $214.6 million in 2012, down from $402.9 million in 2011 but significantly higher than the $60.9 million in venture capital investment reported in 2010. Thus, the decline in venture capital investment in 2012 as compared with 2011 does not suggest declining interest in fuel cells especially because of the

[9] All data is provided by Bloomberg New Energy Finance. There is some investment activity in 2011 that was not reported in Bloomberg's database at the time the 2011 edition of this report was published. Thus, the total investment between 2009 and 2011 was likely higher than the $671.4 million previous reported, but still significantly less than the cumulative total for 2010-2012.

[10] In the 2011 edition of this report, $150 million in investment during Q3 2011 was classified as private equity. The Bloomberg database has since reclassified that investment as private equity.

extraordinary level of fuel cell venture capital investment in the third quarter of 2011 (Figure 2).

Figure 3 provides a breakdown of investment in U.S. fuel cell companies between 2010 and 2012. During this period, approximately 81 percent of the cumulative investment in fuel cells was in U.S. companies. This number remained nearly constant in 2012, with 80 percent of investment, or $245.8 million, made in U.S. companies. The second quarter of 2012 was especially remarkable, with $153.8 million in venture capital funding flowing into U.S. companies.

Table 4, shows the top ten disclosed venture capital and private equity investors in fuel cells in 2012. The total amount of private equity and venture capital investment for the top ten disclosed investors was $190.5 million,[11] significantly higher than the $113.2 million reported in 2011 and the $36.9 million reported in 2010. Moreover, these top ten investors constituted more than 98 percent of disclosed venture capital and private equity fuel cell investors in 2012, and roughly 62 percent of the $307.1 million in total investment activity in 2012. Many of the top ten investors shown in the table are new to the list in 2012, suggesting that the industry is attracting both new capital and new sources of capital.

Table 4: Top Ten Disclosed Venture Capital and Private Equity Investors in Fuel Cells, By Company and By Country (2012)

Top Ten Fuel Cell Investors	
Company	**Amount (millions USD)**
DAG Ventures LLC (U.S.)	37.5*
Kleiner Perkins Caufield & Byers (U.S.)	37.5*
New Enterprise Associates Inc. (U.S.)	37.5*
GSV Capital Corp. (U.S.)	37.5*
Altima Partners LLP (U.K.)	11.7**
F&C Asset Management PLC (U.K.)	11.7**
Artemis Investment Management LLP (U.K.)	11.7**
I2BF Capital Advisors (U.K.)	1.8***
Carbon Trust (U.K.)	1.8***
SC Green Tech Ventures (U.S.)	1.8***
Total (top 10 only)	**$190.5**
Total (all investors)	**$193.8**

Source: Bloomberg New Energy Finance

*Notes: * These four investors equally split the $150M investment in Bloom Energy Corp.; ** These three investors equally split the $35M investment in Intelligent Energy LTD; *** These three investors equally split the $5.3M investment in Acal Energy LTD.*

Table 5 shows the top ten global investors in fuel cells between 2000 and 2012,[12] as well as the countries with the highest level of investment during that period. The top five firms investing in fuel cell companies were U.S. firms, led by Kleiner Perkins Caufield & Byers, which has helped raise more than $1 billion for Bloom Energy since 2002. In aggregate, U.S. investors made the greatest cumulative investment during the period, $801.2

[11] The $190.5 million invested by the top ten investors includes only completed deals where the investors are disclosed. Thus, it is a smaller number than the $214.6 million in total venture capital investment for 2012.

[12] Note that, beginning in 2012, Bloomberg only reports investment in fuel cell companies, not hydrogen. Thus, the totals shown in Table 5 are lower than the totals reported in the 2011 edition of this report, because hydrogen is no longer included.

million, followed by U.K. investors at $266.2 million. Eight of the top ten largest investors in fuel cell companies were from either the U.S. or the U.K., and collectively U.S. and U.K. investors accounted for roughly 73 percent of all investment in the sector between 2000 and 2012.

Table 5: Top Ten Venture Capital and Private Equity Investors in Fuel Cells, By Company and By Country (Cumulative 1/1/2000 – 12/31/2012)

Top Ten Fuel Cell Investors		Top Ten Countries with Highest Levels of Private Investment in Fuel Cells	
Company	**Amount (millions USD)**	**Country**	**Total All VC and PE Investment (millions USD)**
Kleiner Perkins Caufield & Byers	105.7	U.S.	801.2
(U.S.)	71.0	U.K.	266.2
New Enterprise Associates (U.S.)	68.2	Canada	84.3
Mobi Venture Capital, Inc. (U.S.)	54.2	Germany	48.3
GSV Capital Corp. (U.S.)	54.2	South Africa	33.0
DAG Ventures LLC (U.S.)	50.0	Singapore	23.6
Rolls-Royce Holdings PLC (U.K.)	50.0	Australia	22.2
Enertek Services Pte Ltd (Singapore)	36.7	Sweden	21.0
Meditor Capital Management (U.K.)	31.1	Switzerland	18.4
Chrysalix Energy LP (Canada)	27.6	Netherlands	12.7
Conduit Ventures Ltd (U.K.)			
Subtotal (top 10 only)	**$548.7**	**Subtotal (top 10)**	**$1,330.9**
TOTAL (All Companies and Countries)			**1,463.3**

Source: Bloomberg New Energy Finance

SHIPMENTS

The total number of fuel cell systems shipped reached nearly 30,000 units in 2012 (Figure 4). This is roughly a 34 percent increase over total shipments in 2011 and a 321 percent increase over total shipments in 2008. The stationary sector continues to drive overall shipment growth, increasing from about 2,000 shipments in 2008 to about 25,000 shipments in 2012. This is likely due to growth in the backup power market and the success of Japan's residential fuel cell program.

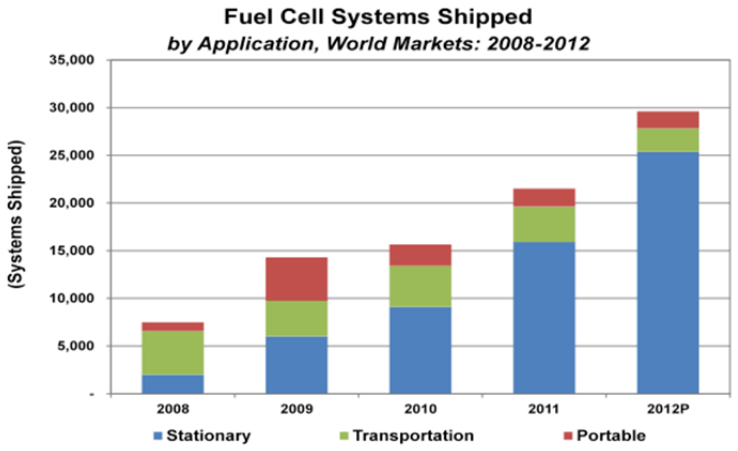

Figure 4: Fuel Cell Systems Shipped by Application, World Markets: 2008-2012. Source: Navigant Research[1]

The transportation and portable markets continue to contract. For transportation, the contraction has been driven in part by the recession, which has driven down demand for luxury recreational vehicles with fuel cell auxiliary power units (APUs). However, these fuel cells are being used in other applications, such as remote sensing, thus not impacting overall shipment numbers. The transportation sector also has not yet seen growth in the material handling market outside of the United States. This is because the economics for fuel cell-powered material handling equipment generally favor large warehouses with multi-shift operations, which are more numerous in the United States, although pockets of opportunity exist in parts of Europe and Asia. The portable market has yet to see commercial products that are competitive with incumbent technologies, such as batteries for cell phones and computers.

The number of megawatts shipped on an annual basis more than doubled between 2008 and 2012, rising from about 60 MW to more than 120 MW (Figure 5). As with the total number of units shipped, the growth is being driven primarily by the stationary market, which has seen increases in both small and large units. There also has been some growth in the number of megawatts shipped for transportation purposes, primarily due to shipments of fuel cell systems for material handling equipment in the United States. However, it is likely that the number of megawatts shipped for transportation will remain relatively flat, unless light duty FCEVs are introduced in significant numbers or the material handling equipment market grows substantially.

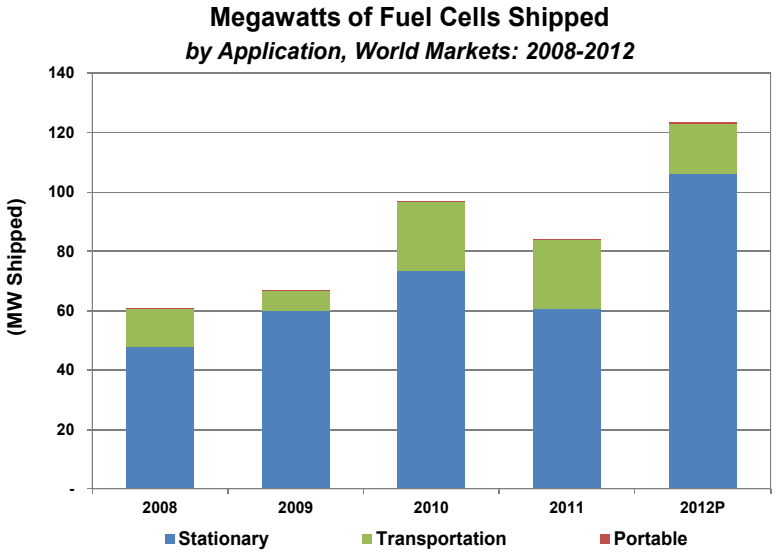

Figure 5: MW of Fuel Cells Shipped by Application, World Markets: 2008-2012. Source: Navigant Research.

The number of fuel cell units manufactured in Asia continued to grow steadily, rising from about 13,500 units in 2011 to roughly 22,000 units in 2012 (Figure 6). The vast majority of these units were stationary, due primarily to Japan's residential fuel cell program. The number of fuel cells manufactured in North America also grew in 2012, rising to about 6,000 units in 2012. This is nearly double the number of units manufactured in 2011, with increases in both the stationary and transportation sectors.

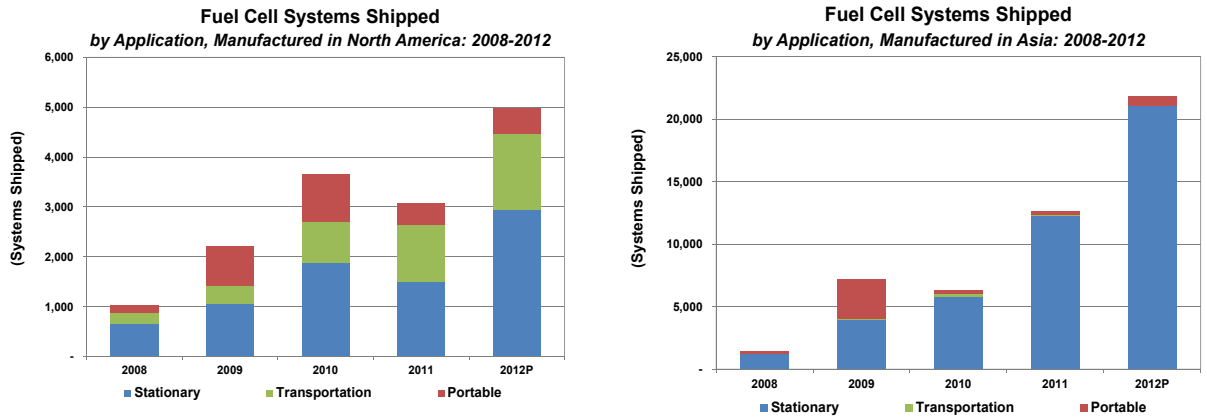

Figure 6: Fuel Cell Systems Shipped by Application, Manufactured in North America and Asia: 2008-2012. Source: Navigant Consulting.

A breakdown of shipments by country of manufacture further exposes this trend. In terms of units shipped by country of manufacture, Japan experienced the greatest growth, increasing from about 1,000 units in 2008 to about 20,000 units in 2012 (Figure 7). The U.S. experienced growth during the same period, rising from roughly 1,000 units in 2008 to nearly 5,000 units in 2012, and South Korea achieved nearly 1,000 units manufactured and shipped in 2012. Germany's unit shipments remained relatively constant during the period, except for a sharp decline in 2012, likely due to the fall in demand for luxury recreational vehicles, some of which use fuel cell APUs.

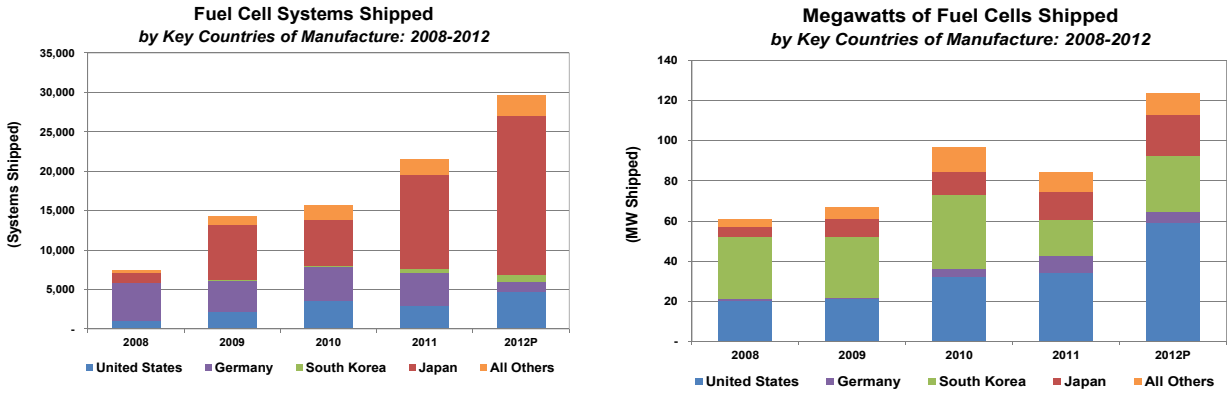

Figure 7: Fuel Cell Systems and MWs Shipped by Country of Manufacture: 2008-2012. Source: Navigant Consulting.

The U.S. appears to be gaining vis-à-vis the rest of the world in terms of total megawatts manufactured and shipped, reaching nearly half of all megawatts shipped in 2012 (Figure 7). This is largely because of increased sales of large stationary fuel cells, such as Bloom Energy Servers and FuelCell Energy units, as well as growth in the backup power market. Japan also experienced growth, but its total MW shipped is less than the U.S. because of Japan's focus on the small stationary market. South Korea is notable for its substantial megawatt shipments, largely due to the manufacturing and sales agreement between FuelCell Energy and POSCO Power.

As shown in Figure 8, the number of units manufactured in Europe dropped from roughly 5,300 units in 2011 to about 2,200 units in 2012. Although stationary, transportation, and portable fuel cell shipments each declined, the bulk of the decrease was in the transportation sector. As discussed above, this is likely due primarily to the decline in demand for luxury recreational vehicles.

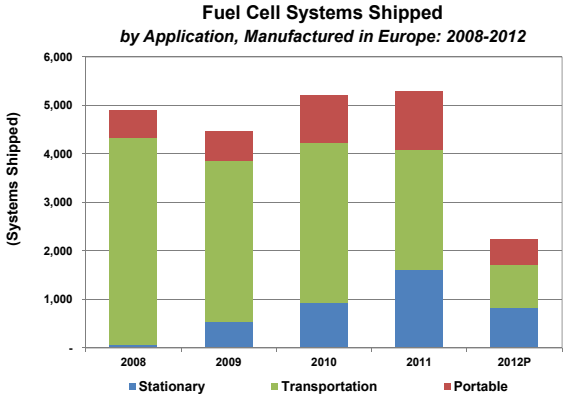

Figure 8: Fuel Cell Systems Shipped by Application, Manufactured in Europe: 2008-2012. Source: Navigant Consulting.

GOVERNMENT POLICY, STANDARDS, AND REGULATION

There were significant regulatory and policy changes in 2012 that affect the market for fuel cells. In August, the Obama Administration finalized new fuel economy standards, raising the requirements to an equivalent of 54.5 mpg for cars and light-duty trucks by Model Year 2025. The standards include incentives for fuel cell electric and other advanced technology vehicles. Overall, the Administration's revised fuel economy standards are expected to save consumers more than $1.7 trillion at the gas pump and reduce U.S. oil consumption by 12 billion barrels.

The U.S. Department of Energy (DOE) made numerous awards through its Fuel Cell Technologies Office in the Office of Energy Efficiency and Renewable Energy to deploy and improve fuel cell and hydrogen storage technologies. Those awards are summarized in Table 6.

Table 6: 2012 DOE Funding Awards

Company	Project	Award
Plug Power	To retrofit 15 electric tow tractors with fuel cells for deployment by FedEx.	$2.5 million
The Eaton Corporation (with Kettering University, Ballard Power Systems, and Electricore, Inc.)	To develop and demonstrate an efficient and low-cost fuel cell air management system.	$2.1 million
3M Company (with General Motors, Lawrence Berkeley National Laboratory, and Michigan Technological University)	To develop a high-performance membrane electrode assembly for use in mass-produced fuel cell electric vehicles.	$3.1 million
Proton OnSite (two awards - $400,000 and $1,000,000), Gas Technology Institute ($400,000), California Air Resources Board ($150,000) and California State University and Los Angeles Auxiliary Services, Inc. ($400,000)	To track the performance and technical progress of innovative refueling systems, and lower costs and improve operation.	$2.4 million total for four projects
Pacific Northwest National Laboratory (with HRL Laboratories, LLC, Lawrence Berkeley National Laboratory, and the University of Oregon)	To advance hydrogen storage technologies to be used in fuel cell electric vehicles.	$7 million
Arbsource and Proton OnSite	Hydrogen production projects.	Small Business Research and Development Grants
Nextgen Aeronautics, Inc.	To incorporate low-cost nano-reinforcement into high-pressure all-composite tank designs for hydrogen storage.	Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase I Release 3 award
Treadstone Technologies Inc.	To develop a novel, low cost structured metal bipolar plate technology for low temperature PEM fuel cells for transportation applications.	SBIR/STTR Phase I Release 3 award

DOE also plans to invest up to $120 million over five years to launch a new Energy Innovation Hub, establishing a multidisciplinary and sustained effort to identify problems and develop solutions across the lifecycle of critical materials. The Hub, funded by up to $20 million in Fiscal Year (FY) 2012, will work to advance U.S. leadership in energy manufacturing -such as electric vehicles, wind turbines, efficient lighting, and others.

California also was active in 2012.

- Governor Brown issued an Executive Order establishing a target to reduce greenhouse gas emissions from the transportation sector to 80 percent by 2050, compared to 1990 levels. Among other things, the order requires the California Air Resources Board (ARB), the California Energy Commission (CEC), the Public Utilities Commission, and other relevant agencies to work with the California Fuel Cell Partnership (CaFCP) to ensure that the state can support the deployment of fuel cell electric vehicles (FCEVs).

- ARB adopted the Advanced Clean Cars Program, designed to combine the control of pollutants and greenhouse gas emissions into a single coordinated package for model years 2017 through 2025. The Program includes the Zero Emission Vehicle (ZEV) Program, which requires manufacturers to offer zero-emission vehicles for sale, including FCEVs. Figure 9 provides an estimate of the growth of the zero emission vehicle fleet anticipated as a result of this rule.

- The CEC released its updated Investment Plan, which includes an additional $11 million for FY 2012-2013 for hydrogen fueling infrastructure.

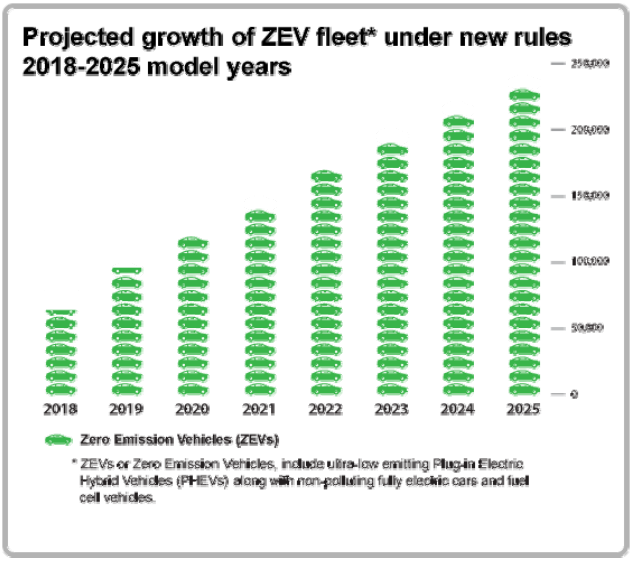

Figure 9: Projected Growth of Zero-Emission Vehicles in California. Source: California Air Resources Board.

There was significant international policy activity.

- In Australia, the State of Victoria broadened its solar feed-in tariff to include all low-emissions and renewable technologies less than 100 kW, including fuel cells. The new tariff will initially provide a minimum of eight cents per kilowatt hour of electricity exported to the grid, which will be adjusted on an annual basis.

- Germany announced a new capital subsidy that will be available for micro combined heat and power (m-CHP) products. Eligible m-CHP products must generate a minimum of 20 kW of electricity, have a total system efficiency of 85 percent, and result in a minimum energy savings of 15-20 percent. These subsidies are only available to homes without access to a district heating network, and range from €1,500 to €3,450 (US$1950-$4500) depending on the output of the system.

- The German Ministry of Transport, together with a coalition of industrial partners, announced their intention to invest more than €40 million (US$50 million) to build 35 new hydrogen fueling stations, which would bring the total number in Germany to 50 by 2015.

- The Danish Government announced a new Energy Plan 2020 that includes a range of initiatives for hydrogen infrastructure and FCEVs, including the continuation of existing tax exemptions for FCEVs through 2015.

APPLICATIONS AND MARKET ASSESSMENT

In 2012, the fuel cell industry continued to attract major customers from a wide range of industries, including computing/software, television/media, real estate development, food/beverage processing, grocery stores, hotels, and warehouse/distribution. Many Fortune 500 companies are using fuel cells as a way to reduce energy costs and improve environmental performance. Early adopters of fuel cell technology also are becoming repeat customers.

Material Handling Equipment

Material handling equipment continues to be a leading market for transport-related fuel cells. Large warehouses in the U.S. have found that fuel cells provide an attractive alternative to battery-powered vehicles and an effective range extender for batteries. As a battery replacement, fuel cells provide nearly continuous operations (refueling takes less than five minutes), provide a continuous level of power (batteries lose power as charge levels decrease), and eliminate the need for battery changing facilities that use valuable warehouse space. As a range extender fuel cells help maintain a constant state of charge, thus reducing or eliminating the need for battery recharging or replacement. The result is that the material handling equipment market provides a clear business case for fuel cell applications, especially in large, multi-shift warehouses where cost savings can quickly justify the additional capital costs for fuel cells and hydrogen infrastructure.

In 2012, the United States continued to be the largest market for fuel cell-powered material handling equipment. More than 4,000 vehicles were operating at nearly 40 locations in 19 states. Just four years ago, in 2008, the total number of fuel cell material handling vehicles was in the hundreds.

There were many new deployments and orders of fuel cell-powered lift trucks, including several from previous customers such as Coca-Cola and BMW. New customers include Procter & Gamble (P&G), Kroger, and Lowe's. Manufacturers of material handling equipment, such as Crown, Raymond, and Yale, are increasingly offering fuel cells as part of their product lineup. Figure 10 shows the top customers for material handling equipment in 2012.

1. **Sysco:** 700+ forklifts at 7 sites
2. **Walmart:** 509 forklifts at 3 sites
3. **P&G:** 340 forklifts at 4 sites
4. **Central Grocers:** 234 forklifts at 1 site
5. **BMW:** 230+forklifts at 1 site
6. **WinCo Foods:** 200+ forklifts at 1 site
7. **Kroger:** 161 forklifts at 1 site
8. **Lowe's:** 161 forklifts at 1 site
9. **Wegmans:** 140+forklfits at 1 site
10. **Coco Cola:** 96 forklifts at 2 sites

Figure 10: Top Fuel Cell Material Handling Customers in 2012. Source: Breakthrough Technologies Institute

Although the U.S. market for fuel cell powered material handling equipment continued to show strength, markets in other parts of the world have yet to develop. Several demonstrations are in operation.

Plug Power is the leading fuel cell company supplying the lift truck market, with more than an 80 percent market share and offering a range of battery replacement products for forklifts, pallet trucks, tow tractors, and counterbalance trucks. Table 7 provides a list of commercially available material handling fuel cell products in 2012.

Table 7: Commercially Available Material Handling Fuel Cells 2012

Manufacturer	Product Name	Type	Output
H2Logic, Denmark	H2Drive	PEM	~10 kW
Hydrogenics, Canada	HyPX Power Packs	PEM / hybrid	N/a
Nuvera Fuel Cells, U.S.	Orion	PEM	10-30 kW
Oorja Protonics, U.S.	OorjaPac Model III	DMFC	20 kWh/day
Plug Power, U.S.	GenDrive Series 1000	PEM	8–10 kW
	GenDrive Series 2000	PEM	8–10 kW
	GenDrive Series 3000	PEM	1.8–3.2 kW

In 2012, Plug Power announced that it had converted 72 lift trucks from batteries to fuel cells at the Mercedes-Benz U.S. International, Inc. facility in Tuscaloosa, Alabama. Plug also announced that the Procter & Gamble Company (P&G) converted more than 200 battery-powered forklifts to fuel cell forklifts at manufacturing facilities in California, North Carolina, and Louisiana, completing a sale that was first reported in 2011. In 2012, Plug sold an additional 140 units to P&G for a facility in Mehoopany, Pennsylvania.

Plug received the Canadian Hydrogen and Fuel Cell Association (CHFCA) commercialization award at the 2012 World Hydrogen Energy Conference held in Toronto. Plug was recognized for its transition from a development stage enterprise to a commercial operation, as demonstrated by the 2,503 orders it received in 2011, a five-fold increase over the 543 orders it received in 2010.[13]

Finally, Plug released an analysis by Walmart, which concluded that fuel cell material handling equipment at a Walmart distribution facility in Canada may result in annual operational savings of US$269,000, far exceeding the additional capital costs of fuel cells as compared with battery-powered equipment.

Table 8 shows major sales for Plug Power in 2012.

Table 8: Notable Plug Power 2012 GenDrive® Sales

Customer	# of Units	Location of Deployment
Procter & Gamble	140	Mehoopany, Pennsylvania
Mercedes-Benz	72	Tuscaloosa, Alabama
Stihl	75	Norfolk, Virginia
Lowe's	161	Rome, Georgia
IKEA	20	France

[13] Company Press Release, available at http://www.plugpower.com/news/pressreleases/12-06-04/PLUG_POWER_RECEIVES_COMMERCIALIZATION_AWARD_AT_WORLD_HYDROGEN_ENERGY_CONFERENCE_2012.aspx

In Europe, ITM Power, a U.K. company, signed an agreement with Infintium Fuel Cell Systems Inc. of Texas to become its exclusive European distributor of fuel cell systems for material handling equipment. ITM Power also signed an agreement with Marks & Spencer for a six-week trial of fuel cell forklifts at its 1.1 million sq. ft. Prologis Park Distribution Center, using the ITM Power HFuel platform to generate hydrogen to fuel the vehicles.

Stationary Power

The stationary fuel cell market includes several sizes and sectors including large-scale systems for prime power, backup power or combined heat and power, small systems for micro combined heat and power for residential or commercial operations, and prime and backup systems for remote or essential applications such as telecommunications towers. Stationary fuel cells come in a variety of types, including molten carbonate fuel cell (MCFC), solid oxide fuel cell (SOFC), phosphoric acid fuel cell (PAFC), and low and high temperature proton exchange membrane (PEM). Stationary power systems exceed all other market segments in terms of annual megawatts shipped, with U.S. companies such as Bloom Energy, FuelCell Energy and UTC Power accounting for the dominant share of shipped capacity. Table 9 provides a list of commercially available stationary fuel cells in 2012.

Table 9: Commercially Available Stationary Fuel Cells 2012			
Prime Power and m-CHP			
Manufacturer	**Product Name**	**Type**	**Output**
Ballard Power Systems, Canada	FCgen-1300	PEM	2-11 kW
	CLEARgen	PEM	Multiples of 500 kW
Bloom Energy, U.S.	ES-5400	SOFC	100 kW
	ES-5700	SOFC	200 kW
	UPM-570	SOFC	160 kW
Ceramic Fuel Cells, Australia	BlueGen	SOFC	2 kW
	Gennex	SOFC	1.5 kW
ClearEdge Power, U.S.	PureCell System Model 5	PEM	5 kW
	PureCell System Model 400	PAFC	400 kW
ENEOS CellTech, Japan	ENE-FARM	PEM	250-700 W
FuelCell Energy, U.S.	DFC 300	MCFC	300 kW
	DFC 1500	MCFC	1,400 kW
	DFC 3000	MCFC	2,800 kW
	DFC-ERG	MCFC	Multi-MW
Heliocentris Fuel Cells AG, Germany	Nexa 1200	PEM	1.2 kW
Horizon Fuel Cell Technologies, Singapore	GreenHub Powerbox	PEM	500 W-2 kW
Hydrogenics, Canada	HyPM Rack	PEM	2-200 kW
	CommScope FC cabinet	PEM	2-16 kW
Panasonic, Japan	ENE-FARM	PEM	250-700 W
Toshiba, Japan	ENE-FARM	PEM	250-700 W
Backup and Remote Power			
Manufacturer	**Product Name**	**Type**	**Output**
Altergy Systems, U.S.	Freedom Power System	PEM	5-30 kW
Ballard Power Systems, Canada	ElectraGen-ME	PEM	2.5-5 kW
	ElectraGen-H2	PEM	1.7, 2.5, & 5 kW
Dantherm Power, Denmark	DBX 2000	PEM	1.7 kW
	DBX 5000	PEM	5 kW
Horizon Fuel Cell Technologies, Singapore	H-Series	PEM	12W-5 kW
Hydrogenics, Canada	HyPM XR Power Modules	PEM	4.5, 8.5, and 12.5 kW
ReliOn, U.S.	E-200	PEM	175-525 W
	E-1000x	PEM	1-4 kW
	E-1100	PEM	1.1-4.4 kW
	E-1100v	PEM	1.1 kW
	E-2200x	PEM	2.2-17.5 kW
	E-2500	PEM	2.5-20 kW
	T-2000	PEM	100W-6 kW+
SFC Energy, Germany	EFOY Pro 800	DMFC	45 W
	EFOY Pro 2400	DMFC	110 W

Prime Power

Today, fuel cells provide clean, reliable power for data centers, commercial buildings, retail stores, multi-family residential buildings, and many other facilities. Fuel cells also increasingly generate electricity from renewable fuel sources, such as bio-gas produced as a by-product of wastewater treatment. The market for fuel cell prime power is growing, although government support is still critical to help offset first costs.

FCE, the Connecticut-based maker of megawatt-scale MCFCs, had significant achievements in 2012. For example, FCE:

- Reached one billion kWh produced by its fleet of Direct FuelCell® (DFC®) power plants;
- Joined with Air Products to develop a tri-generation stationary fuel cell power plant, producing power, heat and hydrogen;
- Extended service agreements with four existing customers to operate and maintain DFC® fuel cells for terms up to 15 years, for a total value of approximately $15 million;
- Formed a German-based joint venture, FuelCell Energy Solutions, GmbH, to market DFC® stationary power plants to the European market;
- Entered into a partnership agreement with Abengoa S.A. to develop fuel cell power plants for markets in Europe and Latin America;
- Bolstered its relationship with POSCO Energy, including receiving a $181 million order for 121.8 MW of fuel cells to be manufactured in Torrington, Connecticut, and entered into a series of a license agreement for POSCO to manufacture DFC® power plants in South Korea and sell throughout Asia;
- Announced that ownership of the world's largest fuel cell park (58.8 MW) in South Korea has been finalized, with POSCO Energy as the sole provider of the fuel cell power plants for the project, which will consist of 21 DFC3000® power plants located in an industrial complex;
- Received a $6 million cost share award from DOE to continue existing research and development of a 60 kW SOFC power plant under phase III of the Solid State Energy Conversion Alliance (SECA) program;
- Entered Phase II of a carbon capture development project under a previously announced award from the DOE's Office of Fossil Energy's Carbon Capture Program; and
- Announced the sale of five DFC®3000 units totaling 14.9 MW to Dominion, which will be installed in Bridgeport, Connecticut.

Bloom Energy also had significant achievements in 2012.

- AT&T announced that it will purchase an additional 9.6 MW of Bloom fuel cells, making AT&T Bloom's largest non-utility consumer with more than 17 MW at 28 sites in California and Connecticut.
- Apple increased its initial 4.8 MW order to 10 MW to help power a new data center in Maiden, North Carolina.
- In April, Bloom broke ground on a new manufacturing facility on a 272-acre site in Delaware, which will bring hundreds of new jobs to the region when completed and doubling Bloom's manufacturing capability.
- eBay Inc. announced plans to install 30 Bloom fuel cells (6 MW) in a new data center. Each of the 30 fuel cells will generate 1.75 million kWh of electricity annually and will displace the need for large and

expensive backup generators and uninterruptible power supply (UPS) components, because the electric grid will be used as backup. The fuel cells will be powered by biogas.

Table 10 provides a summary of major Bloom projects in 2012.

Table 10: Summary of Bloom Energy Installations 2012

Company	City	State	Size
Altera Innovation	San Jose	CA	1 MW
Apple - North Carolina	Maiden	NC	10 MW
AT&T	Numerous CA sites	CA	6.5 MW
Baker Hughes	Shafter	CA	300 kW
Delmarva- Brookside	Newark	DE	3 MW
Honda	Torrance	CA	1 MW
Shark's Ice	San Jose	CA	500 kW
HP Pavilion	San Jose	CA	400 kW
Intuit	San Diego	CA	500 kW
JMB MGM Towers	Los Angeles	CA	400 kW
Juniper Networks	Sunnyvale	CA	1 MW
Kaiser	Numerous Sites	CA	4 MW
Life Technologies - Carlsbad	Carlsbad	CA	1 MW
Roll	Numerous CA sites	CA	4.4 MW
UCSB - SCE Pilot Project	Santa Barbara	CA	200 kW
Target	Numerous CA sites	CA	400 kW
Taylor Farms	Salinas	CA	1 MW
Urban Outfitters	Philadelphia	PA	600 kW
Washington Gas	Washington DC	DC	200 kW
Williams Sonoma	Rocklin	CA	600 kW
Xilinx	San Jose	CA	1 MW
TOTAL			**38 MW**

UTC Power also had significant sales in 2012, including exporting more than 8 MW to Korea. In 2012 United Technologies, the parent company of UTC Power, announced that it intended to sell its fuel cell business. In early 2013, UTC Power was sold to ClearEdge Power. Table 11 shows major UTC Power projects in 2012.

Table 11: Summary of UTC Power Projects 2012		
Location	**Capacity**	**Notes**
South Coast Air Quality Management District (AQMD), Diamond Bar, CA	400 kW	N/A
CTTRANSIT, Hartford, CT	400 kW	CHP for headquarters building.
Pasadena City College, CA	400 kW	Will provide power as well heat the swimming pool.
1211 Avenue of the Americas, New York, NY	400 kW	Located three levels below ground, fuel cell provides significant portion of electricity and hot water for the News Corporation's TV studios.
University of Connecticut's Depot Campus, Storrs, CT	400 kW	Will provide power, heating and cooling to research laboratories and offices.
CBS Studios	2.4 MW	Six UTC Power PureCell® fuel cell systems at two production locations in California.
Saint Francis Care, Hartford, CT	800 kW	Two campuses each installed a 400 kW unit.
SK E&S Power Plant - Pyeongtaek, Korea	5.6 MW	Pyeongtaek Energy Service purchased 14 PureCell® Model 400 fuel cell systems.
Korean South East Power Co. Ltd.'s (KOSEP) Bundang facility - Korea	2.8 MW	Samsung Everland purchased seven PureCell® Model 400 fuel cell systems
TOTAL	**13.6 MW**	

Other developments in large-scale power include:

- Korean company LG invested $45 million in Rolls-Royce Fuel Cell Systems Inc. in North Canton, Ohio, becoming the majority owner. Rolls-Royce, now called LG Fuel Cell Systems, is developing large-scale SOFC systems for industrial, commercial, and utility use.

- AFC Energy and Industrial Chemicals Limited (ICL) teamed up to build the U.K.'s largest fuel cell facility to install 1 MW at ICL's recently built chlor-alkali plant in Essex. The hydrogen generated as a waste product by ICL's chlor-alkali process will be used in AFC's alkaline fuel cell system to generate power.

ClearEdge Power focused on small scale stationary markets in 2012, with two installations in California and one in Austria. The Austrian sale was a result of a multi-phase $500 million agreement with Güssing Renewable Energy GmbH with the ultimate goal of producing 50 MW of energy from fuel cells in the Republic of Austria by 2020. During the first phase, ClearEdge intends to deliver 8.5 MW of fuel cells to Güssing over a 36 month period. ClearEdge Power's outdoor ClearEdge5 system received CSA certification and listing to ANSI/CSA Americas FC-1.

Table 12: Summary of ClearEdge Power Projects 2012		
Location	**Capacity**	**Notes**
Roger's Gardens - Orange County, CA	15 kW	Fuel cells will provide electricity for operations and computer systems and byproduct heat will be used to for the nursery's orchid area.
Lafayette Hotel - San Diego, CA	40 kW	Generates 45 percent of the building's electricity and enough heat to help keep the pool's temperature between 76 and 79 degrees all year round.
Güssing Renewable Energy GmbH - Austria	5 kW	Fuel cell operates using biomethane generated from regional residual biomass. Part of a multi-phase, 50 MW, $500 million agreement.

Micro Combined Heat and Power

An important component of the stationary prime power market is micro combined heat and power (m-CHP). These systems let small business and homeowners generate their own power and use thermal energy from the fuel cell for heating and other purposes.

In 2012, the leading markets for m-CHP continued to be Japan, Europe, and the U.K., with Japan by far the most advanced. As of December 2012, Japan had roughly 43,000 residential m-CHP units installed through its ENE-FARM program, with a government target of 5.3 million units by 2030.[14] Moreover, major suppliers to ENE-FARM continue to report significant progress reducing cost and improving performance.

Panasonic reported that it had reduced the content of both the platinum and oxidation catalysts in fuel cells by 50 percent, reduced the number of components by 20 percent, reduced volume and weight by 26 percent and 10 percent, respectively, and increased durability by 20 percent, to 60,000 hours.[15] Panasonic claims that its most recent model has an overall efficiency of 95 percent on a lower heating value basis, with a recommended retail price of about US$20,000 per unit, a 30 percent reduction from the previous model.[16]

Australian company Ceramic Fuel Cells Limited (CFCL) received customer commitments for 100 BlueGen units in Germany, including from public energy utilities in six German states and from residential and commercial customers. In October, 25 BlueGen units were installed to power Germany's first commercial fuel cell power plant. CFCL also installed three BlueGen units at KIWA Gastec facilities in Apeldoorn, the Netherlands, and one unit in a four bedroom home in the U.K., representing the U.K.'s first installation of an accredited m-CHP fuel cell in a new home.

CFCL's manufacturing partner in France, De Dietrich Thermique received European (CE) certification for its m-CHP system, CERAMIS POWER, powered by CFCL's Gennex® fuel cell module. The first CERAMIS POWER unit will be operated by GDF-Suez, the largest gas retailer in France, and De Dietrich announced plans to deploy 20 units in France, Germany, and Netherlands in 2012.

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[14] Inaka, Hideki; *Challenges for Nationwide Spread of ENE-FARM and Support Program of ACEJ*, Power Point Presentation (2012).
[15] Shimizu, Toshiki; *Panasonic's Latest Technology Trend in ENE-FARM and Penetration Strategy*, Power Point Presentation (2013).
[16] Owano, Nancy. Panasonic trims Ene-Farm fuel cell size and price, Phys.org, 22 Jan 2013. http://phys.org/news/2013-01-panasonic-trims-ene-farm-fuel-cell.html.

Other 2012 m-CHP highlights include:

- Ceres Power entered into a commercial partnership with Itho-Daalderop Group B.V. to develop a low cost mass market CHP product that will be trialed in 2014 and launched in 2016. Itho-Daalderop will also distribute Ceres fuel cell CHP products into the residential mass market within the Benelux countries (Belgium, the Netherlands, and Luxembourg).
- Aspate S.A. is installing Tropical S.A.'s GreenGen N5, 5 kW natural gas fuel cell in 500 new homes over the next three years as part of a green residential construction project.
- Topsøe Fuel Cell of Denmark signed a Memorandum of Understanding (MOU) with South Korean company SK Holdings to work together on the commercialization of fuel cells for residential applications as well as larger stationary units for Asian markets.

Backup and Remote Power

The backup power and remote power market saw significant deployments in 2012, as well as some industry consolidation and new investment. Telecommunications continued to be a leading application but other applications appeared to be gaining some momentum, such as remote sensing and power for pipeline cathodic protection systems. For example, the Colorado Department of Transportation used a fuel cell to recharge batteries on equipment designed to monitor rock slides along Colorado roads. Acumentrics fuel cells were in use at various locations, including a gas distribution facility in Massachusetts and pipelines in Texas. As of January 2012, the Massachusetts fuel cells had accumulated more than 12,000 hours operating time and the Texas fuel cells had accumulated more than 17,700 hours.

In 2012, Ballard Power Systems shipped approximately 400 ElectraGen™ backup power systems and announced that it was acquiring IdaTech's power systems business, expanding its product portfolio by adding a methanol-fueled fuel cell power system. Ballard also expanded its distribution base by signing an equipment supply agreement with Inala Technologies. Table 14 provides a summary of Ballard/Dantherm orders and projects in 2012.

Table 13: Summary of Ballard/Dantherm Orders/Projects 2012

Partner, Location	# of Units	Notes
Idea Cellular, India	30	The Telecom Regulatory Authority of India (TRAI) issued a directive in January, 2012 requiring 50 percent of all rural telecom base station towers and 33 percent of all urban towers in the country to be powered by hybrid solutions within five years. Hybrid solutions involve a combination of renewable energy sources, and include hydrogen fuel cells.
Azure Hydrogen Energy Science and Technology Corporation (Azure), China	50	50 DBX2000 backup power systems for deployment at 30 network sites for trials at outdoor telecom base station sites throughout China – including Beijing, Shanghai, Shenzhen and Xinjiang.
Cascadiant, Indonesia	102	Will be deployed in the networks of two wireless telecommunications companies.
Inala Technologies, Africa	192	A purchase order for the first 32 ElectraGen™-ME methanol fuelled fuel cell systems has been received, with the potential for 192 systems in total.
Nokia, Japan	N/A	System installed at a DOCOMO R&D Center test site in Japan's Yokosuka Research Park.

In July 2012, Altergy Systems announced that it was deploying approximately 22 MW of its *Freedom Power* fuel cell systems, including 1,528 10 kW systems and 437 15 kW systems, for MetroPCS wireless cell tower sites in California. This is the second deployment for MetroPCS – in 2011, 356 Altergy *Freedom Power* systems were deployed at 140 MetroPCS towers in Florida.

ReliOn unveiled several new products in 2012, including the E-1100v fuel cell, a fully integrated system producing up to 1,100 Watts of power in the industry's first vertical-mount chassis. First customer commitments were received from Europe for the communications network of an electrical utility and an emergency backup power application for a Fortune 100 industrial customer. ReliOn also introduced the E-1000x and E-2200x to provide high duty cycle grid-support.

In the United States, Alpha Energy installed a 5 kW ReliOn E-2500™ fuel cell system into its Hybrid Power System (HPS) Test Facility in Bellingham, Washington. ReliOn also was honored by AlwaysOn as one of the GoingGreen Silicon Valley Global 200 winners. The award is designed to recognize leadership in developing technologies that are likely to disrupt existing and entrenched players in green technology.

Clean Energy, a new South African fuel cell company established by the South African Government in partnership with Anglo American Platinum and Altergy Systems, supplied 18 fuel cell backup power systems to mobile phone service provider Vodacom.

Military

The U.S. military continued its support of fuel cell development in 2012, funding research as well as installations. Applications included lightweight soldier power, unmanned vehicles, and stationary power systems. Table 14 shows major fuel cell projects funded by the U.S. military in 2012.

Table 14: U.S. Military Fuel Cell Projects Funded/Completed in 2012

Company	Agency	Project	Funding	FC Type
FuelCell Energy, U.S.	U.S. Navy	Develop and test a Hybrid SOFC -Battery power system for large displacement undersea vehicle propulsion.	$3.8 million	SOFC
SFC Energy AG, Germany	U.S. Army Operational Test Command	For lightweight alternative power sources (LAPS)	N/A	DMFC
NexTech Materials, U.S.	Office of Naval Research (ONR)	Future Naval Capability project to design and develop a compact energy system for unmanned underwater vehicles (UUVs).	N/A	SOFC
Lockheed Martin, U.S.	ONR	Design and development of SOFC generator sets integrated with solar panels.	$3 million	SOFC
Ultra Electronics, AMI, U.S.	U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC)	AMI manufactured 20 of its 250-watt PowerPod fuel cells for TARDEC; 15 fuel cells were delivered to the client and five underwent extensive testing for unmanned ground vehicles (UGV).	$4.2 million multi-year (completed)	SOFC
Ultra Electronics, AMI, U.S.	U.S. Army	Delivered 45 of its ROAMIO D245XR fuel cells for use in unmanned aerial systems.	$2 million (completed)	SOFC
Hydrogenics, Canada	U.S. Air Force Advanced Power Technology Office (APTO)	Develop and deliver a 100 kW outdoor containerized hydrogen power system for the Joint Military Base at Pearl Harbor-Hickam in Hawaii.	N/A	PEM

Portable/Micro

The portable/micro market segment is characterized primarily by fuel cell kits and toys, as well as by small battery chargers that are starting to enter the market. The kits and toys continue to be successful and to account for the largest proportion of annual fuel cell shipments by unit. However, their relatively small power output per unit means that they account for a small proportion of the market in terms of megawatts shipped. Moreover, sales of battery chargers and other similar portable applications have yet to take off, in part because the business case for these products vis-à-vis batteries remains unclear. Table 15 provides a list of commercially available portable and micro fuel cells in 2012.

Table 15: Commercially Available Portable and Micro Fuel Cells 2012

Manufacturer	Product Name	Type	Output
Horizon Fuel Cell Technologies, Singapore	MINIPAK	PEM	Up to 2 W
	HYDROPAK	PEM	50 W
	HYMERA	PEM	150 – 200 W
	HYDROMAX	PEM	180W
Lilliputian Systems, U.S.	Nectar™	SOFC	2.5 W
myFC, Sweden	PowerTrekk	PEM	2.5 – 5 W
SFC Energy, Germany	EFOY COMFORT Series 80, 140, 210	DMFC	40, 72, and 105 W

Transportation

The transportation market segment includes a wide range of applications, such as light and heavy duty vehicles, buses, small aircraft, and ships. It also may include material handling equipment, which is discussed on page 17 of this report. Several large automakers continue to pursue fuel cells for light duty vehicle applications, with commercialization expected in the 2015-2017 timeframe. The number of fuel cell buses continues to increase with deployments in a growing number of countries. The military has had particular success with fuel cells for unmanned aerial vehicles (UAVs).

Fuel cells for transportation are exclusively PEM fuel cells at present. In most applications, the fuel cells are coupled with a battery or other energy storage device. In this configuration, the fuel cell provides either prime power or serves to recharge the battery which is the prime power source. Table 16 shows the commercially available fuel cells for transportation in 2012, not including fuel cells for material handling equipment or proprietary fuel cells being developed by automakers.

Table 16: Commercially Available Fuel Cells for Transportation 2012

Manufacturer	Product Name	Type	Output
Ballard Power Systems, Canada	FCvelocity-HD6	PEM	75 and 150 kW
Hydrogenics, Canada	HyPM HD Modules	PEM	198 kW
Nuvera Fuel Cells, U.S.	Orion	PEM	30 and 110 kW

Light Duty Vehicles

Fuel cell electric vehicles have many advantages over conventional fuel and battery-powered vehicles. They have no tailpipe emissions and, if hydrogen is produced from renewable sources, can provide truly emission-free mobility. Unlike battery vehicles, their range is comparable to existing gasoline vehicles and they can be refueled in minutes. Several major automakers, including Honda, Toyota, and Hyundai, are committed to producing commercial quantities in the 2015-2017 timeframe and reaffirmed those commitments in 2012. Several other automakers say they will not be far behind. The increased volume, coupled with continued technology improvements, is expected to result in significant price reductions.

In January 2012, UKH_2Mobility was launched, bringing together three government agencies, the European Fuel Cells and Hydrogen Joint Undertaking, and 13 corporate participants(including major automakers such as Daimler, Toyota, Hyundai, Nissan, and Tata Motors), hydrogen suppliers (such as Air Liquide and Air Products), and fuel cell manufacturers such as ITM Power. In Phase I, completed in 2012, UKH_2Mobility investigated the potential of hydrogen as a low carbon fuel in the U.K. Focus groups and consumer surveys were conducted. Among other things, the research determined that U.K. consumers were receptive to FCEVs, particularly in terms of range and refueling time, but were concerned about the initial costs of the vehicles and the lack of hydrogen fueling infrastructure.[17] A model was developed that shows U.K. FCEV sales of approximately 10,000 vehicles per year in 2020, with sales increasing rapidly thereafter as vehicle costs become competitive with internal combustion vehicles and the number of hydrogen fueling stations increases. By 2030, the model predicts 1.6 million FCEVs in the U.K. with annual sales of 300,000. Figure 11 shows the results of the modeling.

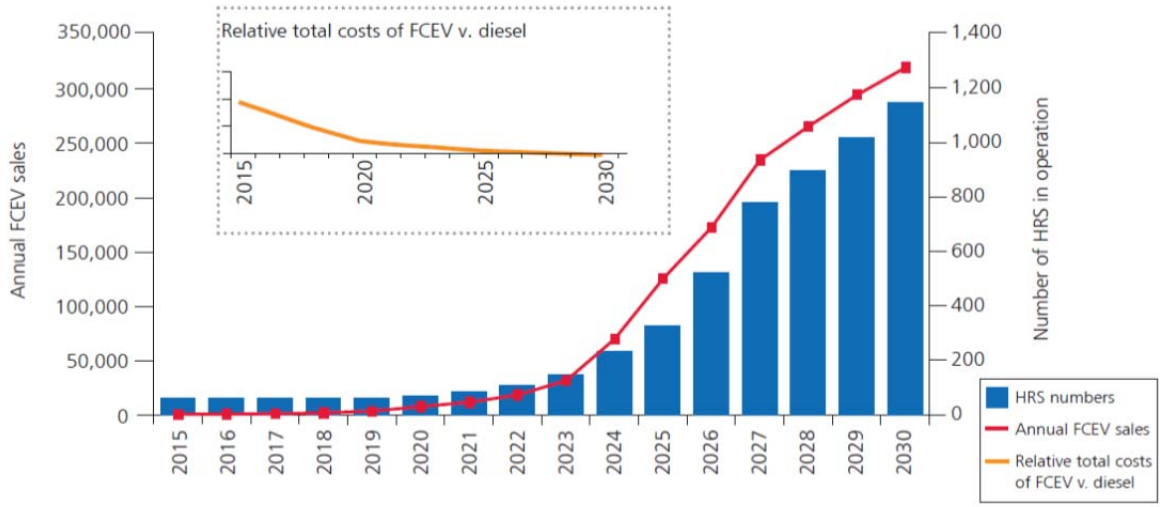

Figure 11: Projected FCEV sales and hydrogen station deployments in the U.K. Source: UKH_2Mobility.

[17] See UKH_2Mobility, Synopsis of Phase I Results (February 2013), available at http://www.itm-power.com/wp-content/uploads/2013/02/UK-H2Mobility-Synopsis-of-Phase-1-Results-Feb-2013.pdf

In Phase II, UKH$_2$Mobility will develop a business case and strategy for the deployment hydrogen infrastructure that will be necessary to support the anticipated introduction of FCEVs in the 2014-2015 timeframe.

The California Fuel Cell Partnership (CaFCP) also took significant steps in 2012 planning for more hydrogen fueling stations in anticipation of the commercial availability of FCEVs in the 2015-2017 timeframe. In July, the CaFCP published *A California Road Map: Bringing Hydrogen Fuel Cell Electric Vehicles to the Golden State*.[18] The *Road Map*, a collaborative effort among industry, government, and academia, concluded that a total of 68 hydrogen stations with a cumulative capacity to serve 20,000 vehicles must be operational in California by the beginning of 2016. California has nine publicly accessible stations, with 14 new or upgraded stations in development.

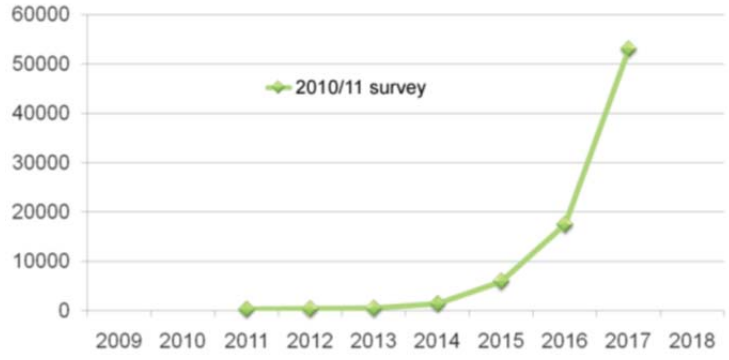

Figure 12: Projected number of FCEVs on the road in California, 2011-2017. Source: California Fuel Cell Partnership.

The road map also included a survey of automakers regarding their projections for the number of FCEVs likely to be deployed in California by 2017. Figure 12 shows that, in aggregate, automakers anticipate that more than 50,000 FCEVs will be on the road in California five years from now.

Other major developments in the light duty sector include:

- Daimler, Ford, and Nissan announced a joint effort to develop a common FCEV platform with initial production of 50,000 vehicles beginning in 2017. Toyota and BMW AG signed an MOU that includes collaborative efforts on fuel cell systems, powertrain electrification, and the development of lightweight technologies.[19]

- Toyota, Nissan, Honda and Hyundai, as well as a number of hydrogen infrastructure companies, signed an MOU to introduce FCEVs and develop hydrogen infrastructure throughout Norway, Sweden, Iceland, and Denmark between 2014 and 2017.

- Six Canadian companies and 20 fuel cell scientists and engineers from academia and government joined together to reduce the platinum used in PEM fuel cells for automotive applications. This CAD$8.1 million (US$8.15 million) project is primarily being funded by the Automotive Partnership Canada (APC), a partnership between five Canadian federal organizations.

- Toyota unveiled the latest version of its proprietary fuel cell stack that achieves a power output density of 3 kW/ liter, more than twice the density and half the size and weight of the fuel cell stack currently used in its fuel cell hybrid prototype.

[18] Available at http://cafcp.org/sites/files/20120720_Roadmapv(Overview)_0.pdf
[19] These announcements were made in January 2013.

- At the 2012 Paris Motor Show, Nissan unveiled its new TeRRa Concept, a 4x4 all-wheel-drive fuel cell crossover utility vehicle. The TeRRa uses a new Nissan-developed fuel cell stack that is 1/6th the cost of the previous 2005 version and the electric portion of the TeRRA Fuel Cell SUV drive train is adapted from the Nissan Leaf.

- Honda equipped its FCX Clarity fuel cell electric vehicle with an outlet to function as a 9 kW power source to serve as a zero-emission mobile electric generator. It is reported that with this outlet, the FCX Clarity can supply enough power to sustain a typical household for six days.

- Mercedes-Benz Canada opened the world's first automated automotive facility dedicated to the production and production technology development of fuel cell stacks in Burnaby, British Columbia.

- Intelligent Energy and Suzuki Motor Corporation created a joint venture called SMILE FC System Corporation, to develop and manufacture air-cooled fuel cell systems for a range of industry sectors. SMILE FC System Corporation will be headquartered in Hamamatsu City, Shizuoka, Japan with operations initially based in Yokohama.

- Five hydrogen fuel cell black cabs developed by Intelligent Energy and partners transported VIPs and dignitaries during the 2012 Summer Olympics in London. This began a two-year trial project supported by the Hydrogen Transport for European Cities (HyTEC).

- Air Products was awarded funding from the Technology Strategy Board (TSB) for a hydrogen fueling station at Heathrow Airport as well as for an additional planned site in central London to fuel the cabs.

- Intelligent Energy and Indian Oil Corporation Limited signed a Statement of Intent to initiate demonstration projects and work collaboratively to develop the use of hydrogen in a range of fuel cell power systems in the Indian market. Under the agreement, Indian Oil and Intelligent Energy will prepare a multi-phased program to demonstrate and eventually deploy hydrogen fuel cells for material handling equipment, telecom towers, and motive applications.

- ECOmove, a consortium of Danish car builders, unveiled the QBEAK, an electric car that can travel 500 miles using a fuel cell range extender.

Fuel Cell Buses

In April 2012, the Federal Transit Administration (FTA) awarded $13.1 million in federal funding for 11 research and demonstration projects under FTA's National Fuel Cell Bus Program. Table 17 shows the projects and funding awards. The projects will develop various fuel cell components, test American-made, fuel cell-powered buses under real-world conditions, and conduct educational outreach about fuel cell buses.

In the United States, fuel cell buses were deployed in Austin, Texas, and Flint, Michigan. The Texas bus was previously operated in Columbia, South Carolina, and was purpose-built by Proterra. This is unlike most fuel

cell buses which are retrofitted using a standard diesel bus chassis. The Michigan bus is from United Technologies and is being leased for $1, with Air Products providing the hydrogen station.

One of the leading fuel cell providers for the bus market, especially the international market, is Ballard Power Systems.

- In 2012, Ballard entered into an equipment supply agreement with Van Hool NV for 21 FCvelocity™ HD6 fuel cell power modules for buses to be deployed in several European cities.

- Ballard signed a Letter of Intent (LOI) with the city of Sao Paulo, Brazil for 25 FCvelocity™-HD6 fuel cell modules.

- In Scotland, the Scottish Government and Scottish Enterprise are providing a combined £3.3 million (US$5.2 million) to the Aberdeen City Council to order 10 hydrogen fuel cell buses and a hydrogen fueling station. The buses will use Ballard fuel cells.

- Ballard executed an MOU with Tata Motors for 12 FCvelocity^{TM}-1100 fuel cell stacks that will be used in fuel cell bus demonstrations planned in various Indian cities. Tata Motors displayed India's first fuel cell bus, with a Ballard fuel cell stack, at the Auto Expo 2012 show.

Table 17: FTA National Fuel Cell Bus Program Awards			
Project	**Amount**	**Lead/Partners**	**Project Overview**
Advanced Generation Fuel Cell Bus	$3,305,000	CALSTART, Pasadena, CA; UTC Power, Hartford, CT; CTTRANSIT, Hartford, CT; BAE Systems, Endicott, NY; New Flyer, St. Cloud, MN	Integrates a smaller, lighter and more powerful UTC Power fuel cell into a full-size New Flyer transit bus.
BUS 2010 NextGen Compound Hybrid Fuel Cell Bus	$1,506,760	CALSTART, Pasadena, CA; BAE Systems, Endicott, NY; Hydrogenics, Ontario Canada; SFMTA, San Francisco, CA	Builds on existing project by integrating an enhanced Hydrogenics fuel cell on an existing hybrid fuel cell bus and operating the bus in transit service.
Austin Fuel Cell Bus Demonstration Program Enhancement	$1,555,978	Center for Transportation and the Environment (CTE), Atlanta, GA; Proterra, Greenville, SC; Hydrogenics, Ontario, Canada; Embedded Power and Controls; Capital Metro, Austin, TX	Expands existing fuel cell demonstration project and puts a new fuel cell electric bus into revenue service.
ECOSaver IV Hybrid Electric Fuel Cell Bus Demonstration	$1,015,480	CTE, Atlanta, GA; DesignLine, Charlotte, NC; Ballard, Lowell, MA; Ohio State Univ., Columbus, OH	Provides funding for DesignLine to complete development of new domestic fuel cell bus. Project includes demonstration with the Ohio State University's Campus Area Bus Service.
American Fuel Cell Bus Enhancement	$1,400,000	CALSTART, Pasadena, CA; SunLine, Thousand Palms, CA; Ballard, Lowell, MA; BAE Systems, Endicott, NY	Continues demonstration of two existing fuel cell buses at SunLine: the American Fuel Cell Bus, and the "Olympics" fuel cell bus.
Massachusetts Hydrogen Fuel Cell Powered Bus	$2,814,600	Northeast Advanced Vehicle Consortium (NAVC), Boston, MA; Nuvera, MA; BAE Systems, Endicott, NY; Massachusetts Bay Transportation Authority, Boston, MA	Upgrades fuel cell in existing fuel cell bus development project to the latest generation Nuvera fuel cell developed for the automotive market.
High Voltage Air Conditioning Converter	$207,930	CALSTART, Pasadena, CA; City of Burbank, CA; US Hybrid, CA	Develops and tests high-efficiency, air conditioning system for hybrid fuel cell buses.
EcoSaver IV Hybrid Electric Fuel Cell Bus Testing and Modeling	$727,075	CTE, Atlanta, GA; DesignLine, Charlotte, NC; Ballard, Lowell, MA; Ohio State Univ., Columbus, OH	Testing and modeling to aid in the design of fuel cell buses.
DC/DC Converter Improvement	$15,000	CTE, Atlanta, GA; Embedded Power and Control; Proterra, Greenville, SC	Project provides critical refinements to a DC-DC converter, a key fuel cell electric bus component.
NFCBP Communications & Outreach	$345,000	CTE, Atlanta, GA	This project will continue outreach efforts to assist the industry in coordinating and disseminating information about fuel cell electric bus technology.
Fuel Cell Bus U.S. Market Analysis and Study	$206,536	CALSTART, Pasadena, CA	Analysis of fuel cell bus market based on input from U.S. transit operators. Analyzes fuel cell bus demand, price sensitivity, consumer acceptance, environmental regulation and policy, energy efficiency benefits, service and maintenance requirements.

Toyota equipped one of its fuel cell buses with a new power supply system that has two electrical outlets inside the cabin that can supply 3 kW, enough to power home appliances continuously for more than 100 hours or be used as mobile power-supply during emergencies. Toyota also is developing a system to supply electricity from a fuel cell bus to a building and plans to test this system in the 2013-2014 timeframe as part of the Toyota City Low-Carbon Verification Project. Toyota intends to launch a new fuel cell bus model in 2016.

Other Transportation Applications

Significant progress continues to be made with specialty vehicles and other unique transportation applications. In 2012 much of the progress was in trucks. Vision Industries Corp. and Balqon Corporation entered into a Joint Development Agreement to build a hydrogen fuel cell/electric hybrid terminal tractor, the Zero-TT, for the distribution center, rail yard, and marine terminal markets. Vision Motors also finalized a purchase order for 100 Tyrano Class 8 Trucks with Total Transportation Services, Inc. TTS and Vision signed a LOI for this purchase in 2011.

Hydrogenics Corporation received orders for five HyPM™HD Series Fuel Cell Power Modules from US Hybrid of Torrance, California, to be used in a dump truck, a step van and several buses as part of a program managed by the Hawaii Center for Advanced Transportation Technologies (HCATT).

In Europe, a consortium was launched to develop a European SOFC APU for heavy duty trucks. The intention is to establish a 100 percent European value chain for the APU and to demonstrate a unit in 2014. The project, known as DESTA ("Demonstration of first European SOFC Truck APU"), is estimated to reduce carbon dioxide emissions by 75 percent, primarily by eliminating engine idling, and achieve reductions in noise, vibration, and other pollutants. Partners include J. Eberspächer GmbH (Germany), AVL List GmbH (Austria), Volvo (Sweden), Topsøe Fuel Cell (Denmark), and Forschungszentrum Jülich (Germany).

Also in Europe, the EcoMotion consortium delivered the final version of its EcoMotion Truck to the Aalborg Zoo. The truck uses methanol fuel cells to recharge batteries and includes a power outlet, enabling zoo staff to run portable electrical equipment from the truck. Proton Power Systems announced the successful first full integration of its fuel cell power and range extender system into a Smith Electric Vehicle's Truck. After road testing, Smith and Proton plan to sell the first 20 vehicles to customers in Germany.

SFC Energy AG received an order from Volkswagen Commercial Vehicles for equipping an additional 242 Volkswagen T5 transporters with its EFOY Pro fuel cell generators. The vehicles are used by the German Federal Office for Goods Transport (BAG) for toll inspection purposes.

In aviation, Boeing partnered with American Airlines and the Federal Aviation Administration (FAA) to launch the ecoDemonstrator program. This program includes a 737-800 airplane that will be a flying test platform for environmentally progressive technologies including a regenerative fuel cell developed in partnership with Japan's IHI Corporation for auxiliary power.

In 2012 Deutsch Aerospace (DLR) flew its upgraded AntaresH2 aircraft to feature a highly integrated fuel cell and hydrogen storage system. DLR's Antares test bed has been flying since 2009.

Other significant developments include:

- The Canadian federal government issued a tender to investigate integrating hydrogen fuel cell technology into three new Canadian Coast Guard ships. Construction of the ships is expected to begin in 2013.

- Professional sailor Andrea Mura used SFC's EFOY COMFORT 210 fuel cell to power the equipment onboard his Open 50 "Vento di Sardegna" racing sail boat during the TwoStar Two Handed Transatlantic 2012 boat race.

- Turkey's Istanbul Technical University (ITU) unveiled a hydrogen fuel cell boat named "Marti" ("seagull"), developed over four years with funding from several organizations, including the Istanbul Metropolitan Municipality and the United Nations Industrial Development Organization (UNIDO).

- Hydrogenics was awarded a development project from the NRC-CSTT (National Research Council – Centre for Surface Transportation Technology) to provide its HYPM™HD 90 for an auxiliary power unit for a hybrid light rail vehicle.

- Vehicle Projects Inc. entered into a partnership with Anglo American Platinum Ltd. on a project to build five fuel cell-powered underground mine locomotives. The locomotives started demonstration in Applets' Dishaba underground platinum mine in Limpopo province mid-2012. Vehicle Projects' hybrid fuel cell power plant uses Ballard Power Systems' FCvelocity-9SSL V4 stacks and K2 Energy lithium-ion batteries. Other project collaborators include Trident South Africa and Battery Electric.

- Ballard Power Systems signed a non-binding MOU with WEG Industries of Brazil to evaluate market opportunities for hydrogen fuel cell products and services in bus, rail, and mining applications.

- Hydrogenics was awarded a follow-on, three-year contract to supply propulsion system equipment including integrated fuel cell power systems, power electronic converters, associated hardware, and propulsion system software.

Hydrogen Infrastructure and Energy Storage

In 2012, more than 200 hydrogen fueling stations were in operation worldwide. The vast majority of stations support research and demonstration activities or bus operations and are not open to the public. The number of public stations is expected to increase significantly as markets prepare for commercial quantities of fuel cell electric vehicles. Table 18 provides a list of commercially available hydrogen fueling systems in 2012 and a more detailed discussion of hydrogen infrastructure progress in 2012 is contained in the Spotlight section of this report.

Table 18: Commercially Available Hydrogen Generation Systems 2012

Manufacturer	Product Name	Type	Output
Avālence	Hydrofiller 15	Alkaline Electrolysis	¾ kg/day
	Hydrofiller 50	Alkaline Electrolysis	3 kg/day
	Hydrofiller 85	Alkaline Electrolysis	5 kg/day
	Hydrofiller 175	Alkaline Electrolysis	10 kg/day
Element 1	H-35 Hydrogen Generator	Reformer	4.5 kg/day
	H-75 Hydrogen Generator	Reformer	9.7 kg/day
	H-110 Hydrogen Generator	Reformer	14.3 kg/day
Hydrogenics	HySTAT	Alkaline Electrolysis	8.6-128 kg/day
	HyLYZER	PEM Electrolysis	1-2 Nm^3/hour
ITM Power	HPac 10	PEM Electrolysis	1.3-5.0 kg/day
	HPac 40	PEM Electrolysis	1.3-5.0 kg/day
	HFuel Hydrogen Station	PEM Electrolysis	5-100 kg/day
	HGas	PEM Electrolysis	25-400 kg/day
Nuvera Fuel Cells	Power Tap	Reformer	50 kg/day
Proton OnSite	HOGEN S Series	PEM Electrolysis	0.56-2.27 kg/day
	HOGEN H Series	PEM Electrolysis	4.31-12.94 kg/day
	HOGEN C Series	PEM Electrolysis	21.6-65 kg/day

New studies in 2012

Various reports, studies, and technical documents published in 2012 highlight the benefits of fuel cell technology in developing low carbon economies and reducing fossil fuel consumption. This section highlights studies and reports that are publicly available free of charge.

The Connecticut Hydrogen and Fuel Cell Coalition and the Connecticut Center for Advanced Technology, with support from the U.S. Department of Energy (DOE) and the U.S. Small Business Administration, released hydrogen and fuel cell roadmaps for eight Northeastern states. These roadmaps are designed to raise awareness of the economic potential and deployment opportunities for fuel cell and hydrogen technology in the Northeast states where the industry has an economic impact of more than $1 billion of total revenue and investment.[20]

[20] http://www.chfcc.org/Publications/reports.asp

The Breakthrough Technologies Institute, with support from the DOE, published *The Business Case for Fuel Cells 2012: America's Partner in Power.*[21] The report is the third in a series and profiles companies either incorporating fuel cells with other technologies such as solar, wind, biogas, or batteries in order to better achieve their sustainability goals, and/or becoming repeat customers and installing large-scale systems at their facilities. Since the 2011 report, U.S. companies added 31.7 MW of fuel cell power and 1,013 fuel cell forklifts.

The Breakthrough Technologies Institute also published *State of the States: Fuel Cells in America 2012,*[22] also the third in a series. The report provides a comprehensive update on state fuel cell and hydrogen policies and installations and features the "2012 Fuel Cell Power Rankings" - nine separate Top 5 lists showcasing the top activity in different states and market sectors.

The California Fuel Cell Partnership (CaFCP) published *A California Road Map: Bringing Fuel Cell Electric Vehicles to the Golden State*. The work is based on CaFCP members' 10+ years of experience placing stations and vehicles in California, and represents more than a year of collaborative work between automakers, researchers, and other stakeholders in California.[23]

The DOE and the National Renewable Energy Laboratory released the *National Fuel Cell Electric Vehicle Learning Demonstration Final Report*, presenting findings from data gathered from vehicles demonstrated under the National Fuel Cell Electric Vehicle Learning Demonstration. During the demonstration, 183 fuel cell electric vehicles were deployed, 25 project fueling stations were placed in use, and no fundamental safety issues were identified. The analyzed data set included more than 500,000 individual vehicle trips, with 3.6 million miles traveled, and more than 152,000 kilograms of hydrogen produced or dispensed.[24]

The Hydrogen and Fuel Cells Interagency Task Force and Interagency Working Group released its Interagency Action Plan which guides collaborative federal agency efforts to research, develop, demonstrate, and deploy hydrogen and fuel cell technologies.[25] Fuel Cell Today published several reports and surveys, including *Fuel Cells and Hydrogen in China*, *Fuel Cell Electric Vehicles: The Road Ahead*, and the *Industry Review 2012.*[26] Finally, NorTech and the Ohio Fuel Cell Coalition released a report forecasting that Ohio could create more than 1,650 fuel cell-related jobs by 2019.[27]

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[21] http://www.fuelcells.org/wp-content/uploads/2012/12/FC-Business-Case-2012.pdf
[22] http://www.fuelcells.org/wp-content/uploads/2012/10/StateoftheStates2012.pdf
[23] http://cafcp.org/sites/files/20120720_Roadmapv%28Overview%29_0.pdf
[24] http://www.nrel.gov/hydrogen/pdfs/54860.pdf
[25] http://www.hydrogen.gov/interagency_action_plan.html
[26] http://www.fuelcelltoday.com/analysis/industry-review/2012/the-industry-review-2012, http://www.fuelcelltoday.com/analysis/surveys/2012/fuel-cell-electric-vehicles-the-road-ahead and http://www.fuelcelltoday.com/analysis/surveys/2012/fuel-cells-and-hydrogen-in-china
[27] http://www.nortech.org/news-room/press-releases/nortech-ohio-fuel-cell-coalition-release-findings-from-inseven-roadmap-process

INTELLECTUAL PROPERTY

The granting of a patent measures the level of innovation within a particular industry and the success of research and development programs. According to the Clean Energy Patent Growth Index report from the Cleantech Group-Heslin Rothenberg Farley & Mesiti P.C., the U.S. led all other countries in clean energy patents. Moreover, between 2002 and 2012, the fuel cell industry received far more patents than any other clean energy technology (Figure 13).

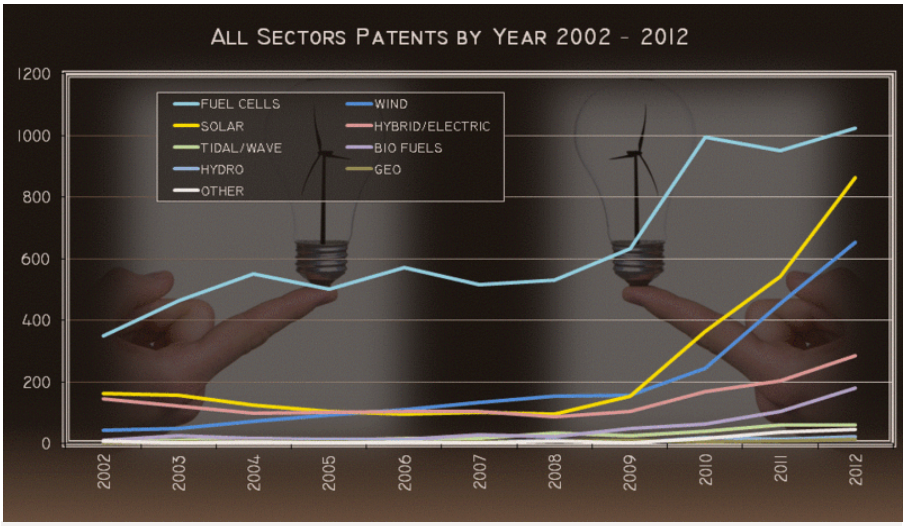


Figure 13: U.S. Patent and Trademark Office Clean Energy Patent Awards By Sector, 2002-2012. Source: Heslin Rothenberg Farley & Mesiti P.C.

As shown in Figure 14, Toyota obtained the greatest number of U.S. fuel cell patents in 2012, followed by GM, Honda, and Samsung. Moreover, between 2002 and 2012, GM, Toyota, and Honda received more fuel cell patents than other companies, suggesting that the level of research and development focused on fuel cell electric vehicles was strong during the period.

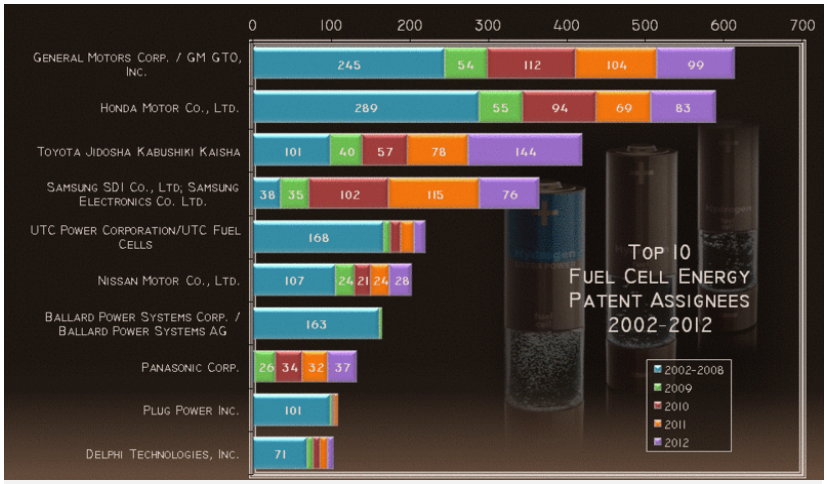


Figure 14: Top Ten U.S. Fuel Cell Patent Assignees (2002-2012)

Fuel Cell Today published *The 2012 Fuel Cell Patent Review*.[28] Among other things, the review analyzed fuel cell patents by country and region of origin between 2000 and 2010. North America and the United States clearly led the world in terms of fuel cell patent awards in 2000 and 2005 (Figure 15). However, in 2010, Japan eclipsed the United States by a slight margin and Asia eclipsed North America by a significant margin. If this trend continues, it suggests that Asia may become the global leader in fuel cell innovation.

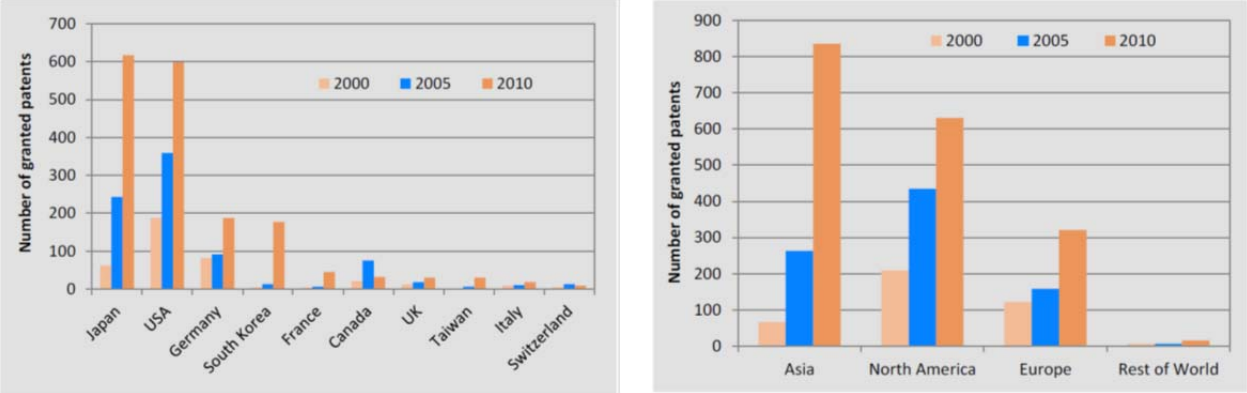


Figure 15: Fuel Cell Patents by Country (Top Ten) and by Region. Source: Fuel Cell Today

[28] Available at http://www.fuelcelltoday.com/media/948977/the_2011_fuel_cell_patent_review.pdf

SPOTLIGHT: INTERNATIONAL HYDROGEN VEHICLE FUELING INFRASTRUCTURE

With several major automakers announcing plans to make fuel cell electric vehicles (FCEVs) available to the marketplace between 2015 and 2017, governments and partner organizations are making a concerted effort to ensure sufficient hydrogen fueling infrastructure. Germany, Japan, the U.K., and the Scandinavian countries collectively are operating more than 50 public hydrogen stations, and more are planned, all supported by government funds. In the United States, nine public stations are open in California, supported by a state program managed by the California Energy Commission (CEC). Two other states have stations available by appointment and regional planning has begun in the Northeast. A variety of technical and management issues are under review.

California's Goal: "ZEV-Ready" … 68 by 2016

Late in 2012, California Governor Jerry Brown signed an Executive Order, the "Zero Emissions Vehicle (ZEV)" Action Plan, that requires California to become "ZEV-ready" by 2015 – installing infrastructure for both FCEVs and plug-in electric vehicles with the goal of 1.5 million ZEVs by 2025.

Nine public hydrogen stations and 15 private stations were operating in California at the end of 2012; the private stations supported small demonstration fleets and research activities. The California Fuel Cell Partnership, in *A California Road Map: Bringing Fuel Cell Electric Vehicles to the Golden State*[29] recommended that 68 strategically located stations be operational by the beginning of 2016. Most recommended stations sites are located within five geographic clusters where a majority of early adopters are expected: Santa Monica/West Los Angeles; coastal Southern Orange County; Torrance with nearby coastal cities; Berkeley; and San Francisco South Bay. Additional stations would connect these clusters into a regional network. Governor Brown endorsed this plan as part of his ZEV-Ready program.

The CEC has invested or allocated about $45 million since FY 2008 for hydrogen fueling, sufficient to fund more than 30 stations, by CEC's own estimate. Additional funds were expected in 2013 and the California Legislature was expected to approve an extension of its Alternative and Renewable Fuels and Vehicle Technology (ARFVT) Program which has funded the effort to date.

Japan's Goal: 100 by 2015

Japan has set a goal of 100 stations by 2015 across populous Southern Japan. The government has embraced a plan to contribute half the cost of the stations, estimated at about $200 million. Nippon Oil & Energy Corp., which supplies about 25 percent of Japan's consumer gasoline, announced plans to operate 40 of the hydrogen refueling stations. Iwatani, a Japanese gas and energy supplier, committed to building 20 stations.

[29] http://cafcp.org/carsandbuses/caroadmap

Three additional hydrogen stations were built in FY 2012 and at the end of the year the total number of public stations in Japan was 17. Japan opened its first public station in a non-industrial area, adjacent to a conventional gas station in Ebina, Kanagawa Prefecture. Japanese regulations had required hydrogen stations to be located in industrial areas, but in 2012 that regulation was changed to allow stations in residential areas and near gas stations. Japan is building a second hydrogen station co-located with gasoline station.

Germany's Goal: 50 by 2015

In 2012, the German Ministry of Transport announced its intention to invest more than €40 million (US$50 million) to build 35 new hydrogen fueling stations together with a coalition of industrial partners. The investment is expected to increase the number of stations in Germany from 15 to 50 by 2015. Twenty of these stations will be provided by Linde through an agreement with Daimler and the German government.

H_2Mobility, an initiative of fuel providers and automakers, has been working toward the establishment of nationwide network of hydrogen fueling stations in Germany since 2009. The group has begun a third phase aimed at establishing a legal entity to work on financing, creating policies/incentives, finding investment, and creating a business model for hydrogen infrastructure.

Germany's Clean Energy Partnership (CEP), established in 2002 and managed by the German Ministry of Transport and Industry, has facilitated hydrogen vehicle deployments and development of hydrogen infrastructure in Berlin, Dusseldorf, Hamburg, Stuttgart, and Karlsruhe. The group is also working to increase the use of renewable energy sources for hydrogen production.

In addition, a major focus in Germany is hydrogen for energy storage to reduce the curtailment of wind power. This hydrogen can be used for transport fuel or to produce power that is fed back to the grid.

Scandinavia's Goal: 45 by 2015

The Scandinavian Hydrogen Highway Partnership (SHHP), a transnational collaboration between three national organizations – HyNor (Norway), Hydrogen Link (Denmark), and Hydrogen Sweden (Sweden) – aims to establish a network of hydrogen refueling stations by 2015 which could include 15 stations and 30 satellite stations. Currently there are 12 hydrogen stations fueling 50 FCEVs in Norway, Sweden, and Denmark. Hyundai delivered the first of its assembly-line-produced ix35 FCEVs to the Municipality of Copenhagen in Denmark.

There is a significant financial incentive to purchase a FCEV: the 100% tax on imported vehicles is waived for a ZEV.

The Danish Government announced a new Energy Plan 2020 that includes a range of initiatives for hydrogen infrastructure and FCEVs, including the continuation of existing tax exemptions for FCEVs through 2015.

In Norway, an Innovation Zone opened at the Hynor Lillestrøm hydrogen refueling station, where new hydrogen technologies can be tested and demonstrated.

Finland

A Finnish hydrogen road map was published by VTT Technical Research Centre, partly funded by the Finnish Funding Agency for Technology and Innovation (Tekes). The report assesses the use of Finland's natural resources and capabilities in biofuels and biomass to generate hydrogen. Finland is prepared for the construction of hydrogen refueling stations through gas company Woikoski Oy.

Europe's Hydrogen Infrastructure for Transport (HIT):

The Hydrogen Infrastructure for Transport (HIT) initiative has been launched to coordinate the roll-out of hydrogen fueling stations in Europe (Trans-European Transport Network or TEN-T), working closely with the German and United Kingdom initiatives. The initial goal is to link Gothenburg, Sweden, with Rotterdam in the Netherlands, establishing a 1,000 kilometer corridor.

United Kingdom's Goal: First 65, then 1,150 by 2030

UKH_2Mobility was launched early in 2012. It focuses on developing a strategy for implementing a hydrogen infrastructure in the UK. The group projects that 65 refueling stations across the U.K. will be needed to get the FCEV market started. The refueling network is projected to expand with demand for FCEVs, with full national coverage achieved by 2030 with 1,150 refueling stations. One of UKH_2Mobility's goals is for more than half of the hydrogen to be generated from renewable resources.

In Scotland, the Aberdeen City Council released *A Hydrogen Economy for Aberdeen City Region*, a strategy framework that presents a platform for the city to build off the £20 million (US$30.5 million) Aberdeen Hydrogen Bus Project, which will bring Europe's largest fleet of fuel cell buses to the region. The aim is to accelerate the development of Scotland's renewable energy sector.

The U.K. is also supportive of hydrogen as an energy storage medium to enable intermittent renewables with companies such as ITM Power and Intelligent Energy as emerging players.

H_2USA

In the United States, the Secretary of Energy signed on to a new public-private partnership, H_2USA, which consists of automakers, government agencies, gas suppliers, and the hydrogen and fuel cell industries. H_2USA is expected to coordinate research, conduct technical and market analysis, and identify cost-effective solutions to deploying fueling infrastructure. An organizing meeting is planned in 2013.

In 2012, a number of public and private hydrogen stations were opened around the world, including:

- *Birmingham, Alabama* – a private station that fuels a demonstration fuel cell bus.
- *Emeryville, California* – a private station that fuels a fleet of fuel cell buses.
- *Newport Beach, California* – a public Shell Hydrogen Station.
- *Honolulu, Hawaii* – a private, off-grid solar hydrogen station for fuel cell scooters.
- *Grand Blanc Township, Michigan* – a private station for a fuel cell bus.
- *Hempstead, New York* – a private station that fuels municipal vehicles opened in 2009. In 2012, a wind turbine was added to generate hydrogen from electrolysis.
- *New Delhi, India* – a private station that fuels hydrogen 3-wheel vehicles.
- *Istanbul, Turkey* – a private hydrogen station for land and sea applications.
- *Milbrook, U.K.* – a private station used at Milbrook Proving Ground.
- *Nottingham, U.K.* – a private university station for hydrogen vehicles and a research lab.
- *Swindon, U.K.* – a public hydrogen station located at a Honda plant.
- *Brussels, Belgium* – a private station that will deliver hydrogen for forklifts, buses, and other vehicles.
- *Brugg, Switzerland* – a private station for a fleet of fuel cell buses.
- *Aargau, Switzerland* – a private station that fuels a fleet of fuel cell buses.
- *Vienna, Austria* – a publicly-accessible hydrogen pump integrated into an existing OMV gas station.
- *Düsseldorf, Germany* – a public hydrogen filling station.
- *Freiburg, Germany* – a publicly-accessible solar-hydrogen station located at Fraunhofer-ISE.
- *Hamburg, German* – a public hydrogen station for fuel cell buses and vehicles.
- *Lilleström Norway* – a hydrogen station that will demonstrate renewable hydrogen generated from a variety of sources.
- *Oslo, Norway* – a private station that fuels buses.
- *Saitama Prefecture, Japan* – a Honda hydrogen station that is open to the public.
- *Arctic Circle, Finland* – a station was opened 150 meters north of the Arctic Circle, at the Arctic Driving Center in Finland.

Table 19: Status of Fuel Cell Passenger Vehicle Development and Deployments				
Automobile Manufacturer	**Commercialization Goal**	**FCEV R&D Partners**	**Country MOU**	**Current Status**
Daimler	As early as 2017	Ford, Nissan	U.K., U.S.	First FCEV in series production. 200 leased in Germany and the U.S.
Ford	As early as 2017	Daimler, Nissan		R&D
General Motors	None announced		U.K. (Opel/Vauxhall)	About 100 FCEVs located in the U.S.
Honda	~2015		Japan, Nordic Countries (Norway, Sweden, Iceland, and Denmark), U.S.	About 200 FCEVs are leased, mostly in the U.S.
Hyundai	2014-2015, goal to sell 1,000 units by 2015, plans to introduce next-generation model in 2015 and scale-up sales to 10,000 vehicles.		City of Copenhagen, Nordic Countries (Norway, Sweden, Iceland, and Denmark), U.K.	Sent 15 FCEVs to Copenhagen. Operates commercial fuel cell electric vehicle assembly line.
Nissan	As early as 2017	Daimler, Ford	Japan; Nordic Countries (Norway, Sweden, Iceland, and Denmark), U.K., U.S.	Introduced a new fuel cell stack in 2011. Showed fuel cell concept vehicle in 2013.
Toyota	2015	BMW	Japan, Nordic Countries (Norway, Sweden, Iceland, and Denmark), U.K., U.S.	Limited number of FCEVs in demo trials in the U.S. and Japan.

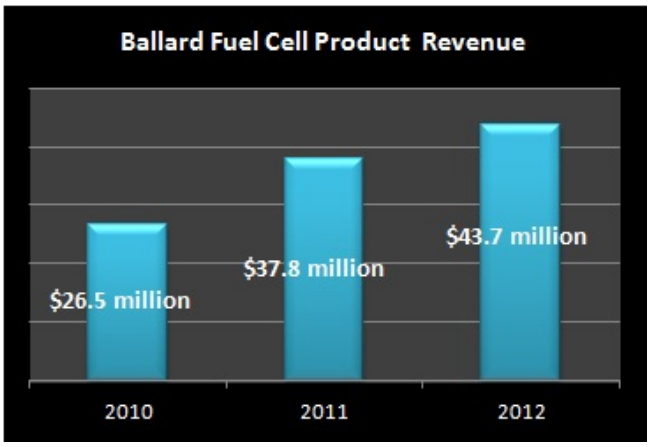
APPENDIX I: COMPANY PROFILES

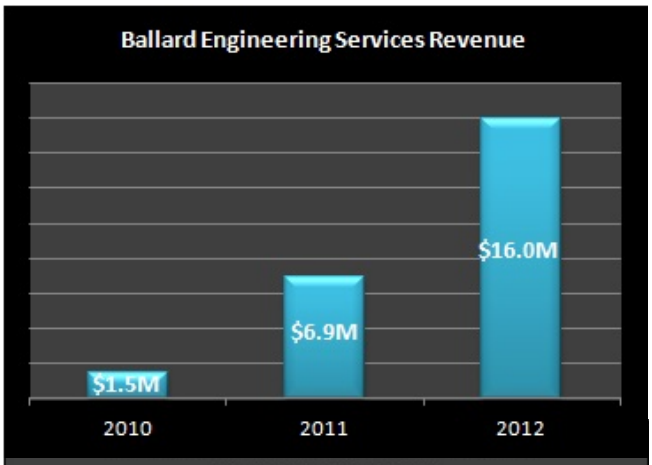
Public Companies

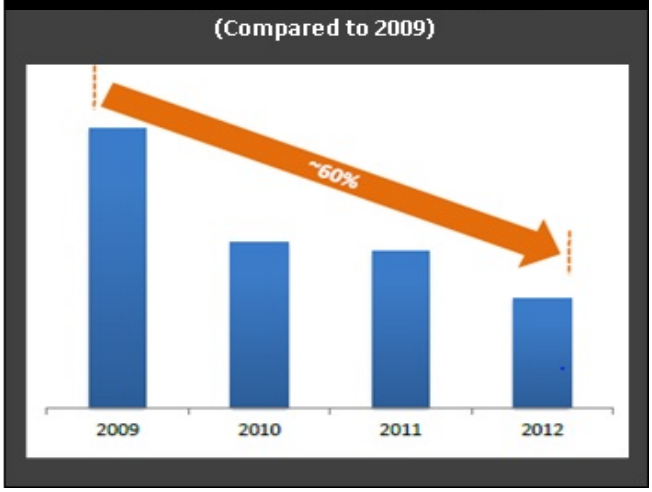
Ballard Power Systems, Inc.

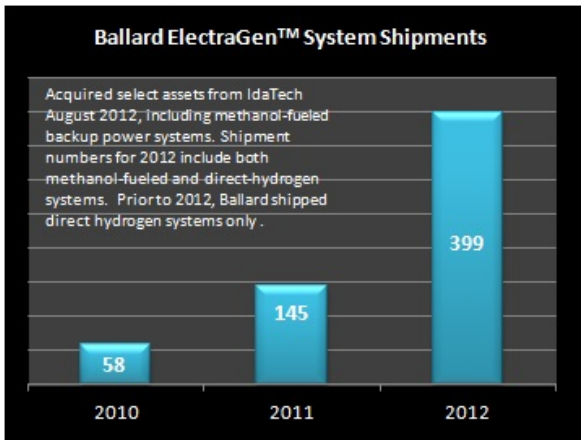
Ballard Power Systems, Inc. was founded in 1979, under the name Ballard Research Inc., and in 1983 began developing fuel cells. The company's principal business is the design, development, manufacture, sale, and service of fuel cell products (both stacks and systems), focusing on commercial stage markets (telecom backup power, material handling equipment) and development stage markets (bus and distributed generation), and also provides engineering services for a variety of fuel cell applications. To date, Ballard has designed and shipped almost 150 MW of hydrogen fuel cell technology. Ballard also holds controlling interest in Dantherm Power. Dantherm Power A/S, a Denmark-based corporation jointly owned with Danfoss Ventures A/S and Dantherm A/S that develops clean energy backup power systems across Europe.

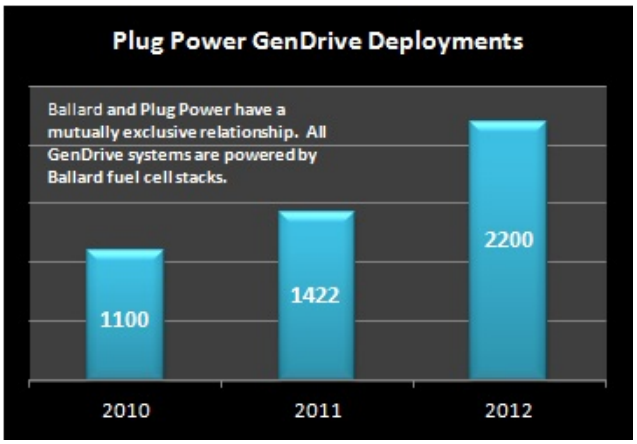
In August 2012, Ballard acquired key assets from IdaTech, including fuel cell product lines for backup power applications, distributor and customer relationships, and a license to intellectual property, in return for $7.7 million of Ballard common shares at a price of $1.08 per share (transferred to IdaTech's principal funder, Investec, a South African specialist bank and asset management company). Ballard has supplied IdaTech with fuel cell stacks for its methanol-fueled ElectraGen systems over the past few years.











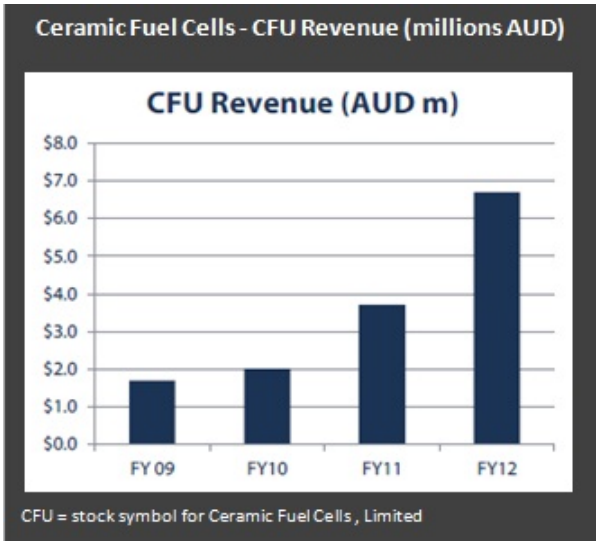
Ballard Power Systems www.ballard.com	
Company Type	Public: TSX:BLD, NASDAQ:BLDP
Headquarters	Burnaby, Canada
Operations	• Canada - headquarters, R&D, production facility • U.S. - R&D (University of Maryland; Bend, Oregon) • Mexico - production facility • Denmark - production facility
Employees	340 plus 30 contractors in Mexico • 271 in Canada • 29 in the U.S. • 40 in Denmark • 60 contractors in Mexico
Fuel Cell Type	PEM
Market Application	Backup power, distributed generation, material handling, buses
Fuel Cell Manufacturing Capability	75 MW per year

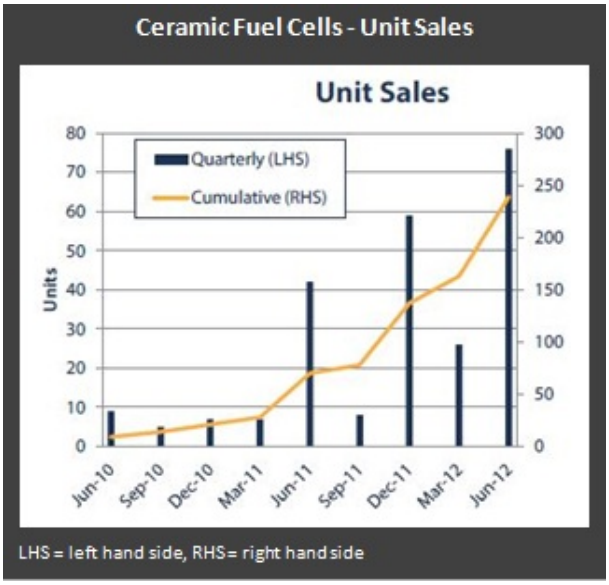
NOTABLE 2012 NEWS:

- Ballard acquired fuel cell manufacturer IdaTech.
- Cash operating expenses decreased 18% to $30.3 million, down from $37.0 million in 2011.
- About 1600 forklifts were deployed using Plug Power GenDrive systems with Ballard fuel cell stacks. Plug Power and Ballard hold an 85% U.S. market share in the fuel cell material handling equipment market.
- Shipped 399 methanol and direct hydrogen backup power systems.
- Announced a partnership with Anglo American Platinum on a number of early-stage stationary and motive fuel cell applications in South Africa.

Ceramic Fuel Cells Limited

Ceramic Fuel Cells Limited (CFCL) was formed in 1992 by Australia's Commonwealth Science and Industry Research Organization (CSIRO) and a consortium of energy and industrial companies. CFCL offers a natural gas-powered micro-CHP SOFC "modular generator" product called BlueGen®; which uses the Company's Gennex® fuel cell module and shares many balance of plant components, allowing CFCL and its partners to create different products and customer offerings from the same core technology platform. CFCL has sold its BlueGEN gas-to-electricity generator to major utilities and other foundation customers in Germany, the U.K., Switzerland, the Netherlands, Italy, Japan, Australia, and the United States. CFCL is also developing fuel cell power and heating products with energy companies E.ON UK in the United Kingdom, GdF Suez in France, and EWE in Germany. The company operates a ceramic manufacturing plant in the U.K. and a 40,000 sq. ft. high-volume fuel cell assembly plant in Germany.





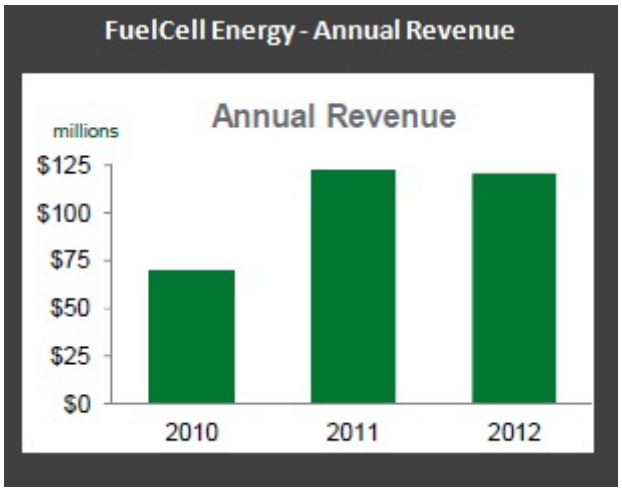
Ceramic Fuel Cells Limited www.cfcl.com.au	
Company Type	Public: AIM/ASX:CFU
Headquarters	Melbourne, Australia
Operations	• Australia - headquarters R&D • U.K. - sales office, ceramic powder plant • Germany - high volume assembly plant, European Marketing & Sales
Employees	135 employees: • 72 in Australia • 55 in Germany • 8 in the U.K.
Fuel Cell Type	SOFC
Market Application	Stationary, micro-CHP
Fuel Cell Manufacturing Capability	Germany - Design capacity: 20 MW per year. Current dispensing & sintering capacity: approximately 5 MW per year

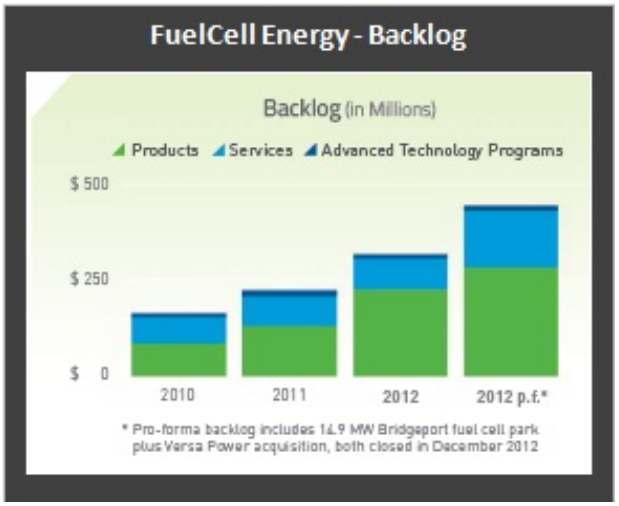
NOTABLE 2012 NEWS:

- Revenue increased by 82%, up to $6.7million. Revenue has increased consistently over the last four years.
- Received cumulative orders for more than 600 units, an increase of more than 100% on the order book as of June 2011.
- Number of units sold increased by 177% from 61 units in FY2011 to 169 units in FY 2012. 78% of sales were in Germany, the Netherlands and the U.K.
- Reduced component costs of products by an average of 25% from 2011.

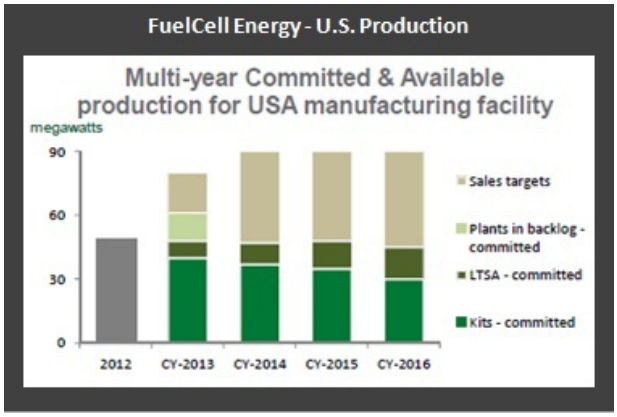
FuelCell Energy, Inc.

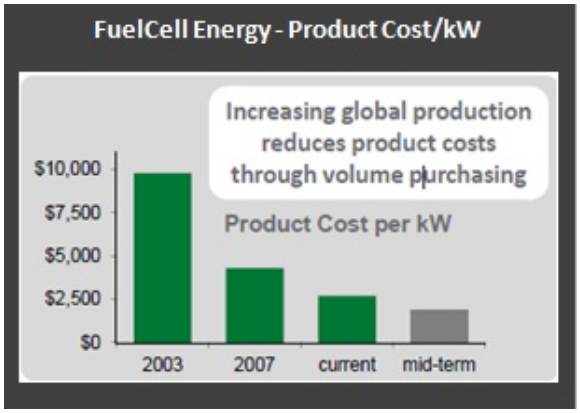
FuelCell Energy (FCE) - which was formed in 1969 as Energy Research Corporation (ERC) and renamed FuelCell Energy in 1999 - manufactures Direct Fuel Cell® (DFC®) MCFC stationary fuel cell power plants that can be used for on-site power generation, cogeneration, CHP, and distributed energy grid support. The power plants internally reform readily available fuels such as natural gas and anaerobic digester gas into the hydrogen gas required to power the fuel cell system. Customers include electric utilities, universities, industrial operations, food processors, municipal water treatment facilities, government installations, and others. Plants are operating in more than 50 locations worldwide and have generated more than 1.5 billion kilowatt hours (kWh) of electricity, equivalent to powering more than 135,000 average size U.S. homes for one year. FCE scientists are also researching applications for DFC technology, including hydrogen generation and carbon capture, and are pursuing research with solid oxide fuel cells, and hydrogen compression and storage.





Based in the U.S., FCE has entered into several international partnerships. Germany's Fraunhofer IKTS and FCE jointly own FuelCell Energy Solutions, GmbH (FCES), a German-based company that develops, manufactures, sells, installs, services, and operates stationary fuel cell power plants in the European Served Area. FCE has also partnered with South Korea's POSCO Power to manufacture DFC® components and power plants for sale in Asia, and has granted Spain's Abengoa has non-exclusive distribution rights for DFC® power plants in Spain and Latin America.





In December 2013, FCE acquired Versa Power Systems, Inc., a developer of solid oxide fuel cell technology. Prior to this action, FCE owned approximately 39 percent of Versa Power and partnered with Versa under the U.S. Department of Energy's Solid State Energy Conversion Alliance (SECA) coal-based systems program.

FuelCell Energy www.fuelcellenergy.com	
Company Type	Public: NASDAQ:FCEL
Headquarters	Danbury, Connecticut
Operations	• U.S. headquarters (Danbury, Connecticut), manufacturing facility (Torrington, Connecticut) • Germany - European sales and service, manufacturing facility • South Korea, through partner, POSCO Power - Asia sales and service, manufacturing facility
Employees	541 employees: • Full-time employees: 484 (226 at the Torrington, Connecticut manufacturing plant, 243 at the Danbury, Connecticut facility or various field offices, 15 in foreign locations) • The acquisition of Versa Power Systems added an additional 41 full-time employees: 10 (Colorado), 31 (Canada). • Temporary employees: 16 (the majority are located at the Torrington, Connecticut manufacturing plant)
Fuel Cell Type	MCFC
Market Application	Large stationary power
Fuel Cell Manufacturing Capability	• 90 MW (Connecticut) • 70 MW (South Korea) • 20 MW (Germany)

NOTABLE 2012 NEWS:

- Annual production rate is 56 MW.
- Installed base and backlog exceeds 300 MW.
- Acquired Versa Power Systems, Inc.
- Established FuelCell Energy Solutions (FCES) in June 2012, a joint venture with Germany's Fraunhofer IKTS.
- POSCO Energy, which owns approximately 16 percent of the outstanding common stock of FuelCell Energy, is licensed to manufacture Direct FuelCell® components and power plants in South Korea for sale in Asia.

Hydrogenics Corporation

Hydrogenics Corporation, founded in 1988 under the name “Traduction Militech Translation Inc.,” began its fuel cell technology development business in 1995. Hydrogenics and its subsidiaries design, develop, and manufacture hydrogen generation products based on water electrolysis technology, and fuel cell products based on proton exchange membrane (PEM) technology. The company’s products span a range of applications, including hydrogen generators for industrial processes and fueling stations; hydrogen fuel cells for electric vehicles, such as urban transit buses, commercial fleets, utility vehicles, and electric lift trucks; fuel cell installations for freestanding electrical power plants and uninterruptible power supply (UPS) systems; and hydrogen storage and power systems for optimizing solar and wind systems during lulls and peaks. Hydrogenics has two reporting segments – OnSite Generation and Power Systems, with OnSite Generation accounting for roughly 80 percent of Hydrogenics’ revenue. Corporate headquarters are located in Mississauga, Canada and other corporate and sales offices are operating in countries around the world. The OnSite Generation business segment is based in Oevel, Belgium and develops products for industrial gas, hydrogen fueling, and renewable energy storage markets. The Power Systems business segment is based in Mississauga, Canada, with a satellite facility in Gladbeck, Germany and develops products for energy storage and stationary and motive power applications.

Hydrogenics www.hydrogenics.com	
Company Type	Public: TSX:HYG, NASDAQ:HYGS
Headquarters	Mississauga, Canada
Operations	• Canada - headquarters • Germany, Belgium and Canada - manufacturing • Russia, China, India, Europe, U.S. and Canada - service centers
Employees	145 employees: • OnSite Generation business: 83 (Belgium) • Power Systems business: 58 (Canada, Germany) • Service centers: 4 (Russia, China, India, U.S.)
Fuel Cell Type	PEM
Market Application	Renewable energy storage, transportation, backup power, hydrogen generation
Fuel Cell Manufacturing Capability	• 160 MW per year fuel cell units • 25 MW per year hydrogen generation units • 25 MW per year renewable energy systems

NOTABLE 2012 NEWS:

- Reported revenues of $27.5 million from the OnSite Generation business and $4.3 million from the Power Systems business.
- Received a CAN$5 million equity investment by Enbridge Inc. to develop hydrogen energy storage “Power-to- Gas” opportunity which includes the opportunity to participate in up to 50% ownership in a build-own-operate model for energy storage services.
- Announced a Memorandum of Understanding (MOU) with Iwatani Corporation to develop opportunities in Japan for hydrogen solution offerings targeting Japan's growing demand for utility scale hydrogen energy storage, hydrogen generation fueling, fuel cell integration and industrial hydrogen generation.
- Received the International Association for Hydrogen Energy's (IAHE) 2012 Sir William Grove Award acknowledging leadership in the electrochemical area of fuel cells and electrolysis.

ITM Power

U.K.-based ITM Power designs and manufactures hydrogen energy systems for energy storage and clean fuel production based on water electrolysis. The company is focused on deployment of technology and products in existing and emerging markets ranging from hydrogen fuelling stations to power-to-gas solutions for grid scale energy storage. The hydrogen fuelling stations have been deployed to enable the roll out of a hydrogen infrastructure for transportation applications from fuel cell cars and buses to material handling equipment vehicles. ITM Power is a founding partner of both the UKH_2Mobility initiative and the H_2USA public-private partnership which are government and cross-industry programs to make hydrogen powered travel in the U.K. and United States a reality.

ITM Power www.itm-power.com	
Company Type	Public: AIM:ITM
Headquarters	Sheffield, England
Operations	UK - two research, development and manufacturing facilities
Employees	66
Fuel Cell Type	PEM
Market Application	Hydrogen generation (PEM-based), hydrogen fuelling, energy storage
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 NEWS:

- HFuel transportable hydrogen refueling station product received regulatory approval for the German market.
- Signed an Equipment Development and Lease Agreement with Boeing Research & Technology Europe S.L.U. for the development, assembly and field trials of a 1Nm^3/hr (2.1kg/day) PEM electrolyzer, which will form part of Boeing's current off-grid refueling station for Unmanned Aircraft Systems (UAS).
- Signed a Letter of Intent with one of Germany's top 10 local utility companies to investigate Power-to-Gas energy storage.
- Signed an agreement with GMI Renewable Energy Group Ltd. to offer an integrated renewable power generation and hydrogen production system for backup power, industrial processes and refueling solutions for material handling equipment in commercial buildings. ITM Power will provide the hydrogen generation and refueling equipment and, if required, the fuel cell systems to enable customers to produce zero carbon hydrogen at the point of use.

Panasonic

Panasonic was founded in 1918 as the Matsushita Electric Industrial Co., Ltd. and is headquartered in Osaka, Japan. The company has grown to become one of the largest electronic product manufacturers in the world, comprised of over 680 companies. In 2006, Matsushita Battery Industrial, a branch in the Panasonic Corporation, showed a DMFC laptop at the International Consumers Electronic Show. Panasonic has also been developing residential micro-CHP fuel cells since 1999 and, along with several partners (including Toshiba), launched the residential ENE-FARM fuel cell brand in the Japanese market in 2009. The 2011 ENE-FARM model features significant simplification of the fuel cell unit and miniaturization of core components, making the price more affordable. The company now plans to follow on the ENE-FARM success by extending its operations into Europe. Panasonic opened its Fuel Cell Development Office Europe in Langen, Germany in 2011 to focus on developing residential fuel cells for the European market in close collaboration with leading European utility companies.

Panasonic http://panasonic.net	
Company Type	Public: TYO:6752, NYSE:PC
Headquarters	Osaka, Japan
Operations	• Japan - headquarters, R&D • Germany - R&D • Wales - R&D (planned)
Employees	Not reported
Fuel Cell Type	DMFC, PEM
Market Application	Residential, consumer electronics
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 NEWS:

- Announced plans to open a fuel cell research and development centre in Cardiff, Wales in September 2012.
- Announced development of a direct methanol fuel cell (DMFC) for mobile applications (20 W) and for portable generators (100 W).

Plug Power

Plug Power is involved in the design, development, commercialization, and manufacture of PEM fuel cell systems in the material handling equipment market. The company was incorporated in 1997 as a joint venture between Edison Development Corporation and Mechanical Technology Inc. and, in 2007, merged with Cellex Power Products and General Hydrogen Corporation. Plug Power currently is focusing on its GenDrive® product line, a hydrogen-fueled PEM fuel cell system designed for industrial vehicles, especially material handling equipment and automated guided vehicles at high volume manufacturing and distribution facilities. The company has deployed over 3,000 GenDrive units with run times exceeding 8.5 million hours.

Plug Power www.plugpower.com	
Company Type	Public: NASDAQ:PLUG
Headquarters	Latham, New York
Operations	Latham, New York - headquarters, manufacturing
Employees	145
Fuel Cell Type	PEM
Market Application	Material handling equipment
Fuel Cell Manufacturing Capability	10,000 units per year

NOTABLE 2012 NEWS:

- Product shipments increased to 1,391 units, a 35% growth from the 2011 shipments.
- Customer base expanded with new, first-time orders. Plug Power also received additional orders from existing customers.
- Completed the introduction of the new product platforms in the third quarter, reducing material cost by an average of 30%.
- Completed an underwritten public offering of 13,000,000 shares of its common stock in March. The shares were sold at a price to the public of $1.15 per share for gross proceeds of approximately $15.0 million.
- Awarded $2.5 million by the U.S. Department of Energy (DOE) to modify electric tow tractors to function with GenDrive® hydrogen fuel cells in airport applications. Under a three-year initiative, 15 tow tractors will be deployed at FedEx Express airport hub locations in Memphis, Tennessee and Oakland, California, to study the productivity, efficiency and the environmental benefits of using hydrogen to fuel ground support equipment.
- Received the Canadian Hydrogen and Fuel Cell Association (CHFCA) commercialization award at the 2012 World Hydrogen Energy Conference recognizing achievements by in commercialization and manufacturing of hydrogen and/or fuel cell products.
- Experienced a number of quality issues in 2012 that negatively impacted financial performance. Quality issues were technically addressed, and a majority of the changes were implemented by the end of the fourth quarter. Plug believes the quality issues caused sales to be delayed by six to nine months, though the company felt it was successful in maintaining customer loyalty. Increased costs and delayed sales forced Plug to adopt a restructuring plan in the fourth quarter to improve organizational efficiency and conserve working capital needed to support the growth of its GenDrive business.

SFC Energy AG

Founded in 2000, SFC Energy produces DMFC fuel cells for mobile and off-grid power applications serving the leisure, industrial, and defense markets. The company's products generate power for consumer applications (e.g. mobile homes, yachts, vacation cabins), industrial and professional off-grid and grid-based power scenarios (e.g. traffic-monitoring systems, observation stations, metering and early-warning devices, electric cars), and for defense and security applications (e.g. field chargers, vehicle-based, portable, and covert power solutions). SFC has alliances with leading companies in a wide range of industries and has shipped more than 27,000 fully commercial products to industrial and private end users in more than five years. SFC's fuel cells and fuel cartridges are manufactured in Germany at the company headquarters near Munich which is also the site of the company's research and development department. SFC Energy operates facilities in the Netherlands and Romania and a sales and service organization in the United States. Equally successfully, the group develops, produces, and globally distributes higher level power management components, e.g. converters and switched mode power supplies. SFC Energy products increasingly are delivered as power supply system solutions according to customer requirements. SFC is DIN ISO 9001:2008 certified.

SFC Energy AG www.sfc.com	
Company Type	Public: DBPS:WKN 756857
Headquarters	Brunnthal, Germany
Operations	• Germany (SFC Energy Group) - headquarters, R&D, manufacturing • The Netherlands (PBF Group B.V.) - R&D, production of power supplies • Romania (PBF Power S.R.L.) - R&D, production of power supplies • Rockville, Maryland (SFC Energy Inc.) - sales and service subsidiary for SFC Energy Group products in North America
Employees	189 worldwide
Fuel Cell Type	DMFC
Market Application	Leisure, industrial and defense, security
Fuel Cell Manufacturing Capability	More than 20,000 units per year

NOTABLE 2012 NEWS:

- In FY 2012, SFC Energy Group revenue was approximately 31 million Euro.
- Substantially increased sales volumes over 2011 in the Defense and Security segments.
- Major order of the German Bundeswehr for the equipment of soldiers with the SFC energy network consisting of the portable JENNY fuel cell, the SFC Power Manager, a hybrid battery, and a solar panel.
- SFC Energy Inc., the U.S. subsidiary of SFC Energy AG, was awarded $1 million by the U.S. Air Force to mature its portable 50 Watt DMFC to production readiness.
- Follow-up order by Volkswagen Commercial vehicles for equipping another 242 toll inspection vehicles of the German Federal Office for Good (BAG) with EFOY Pro fuel cell generators.
- Signed a distribution agreement with power conversion device distributor, ACAL BFi, to offer SFC Energy's range of EFOY Pro fuel cell generators as part of their Power Solutions portfolio.
- Signed an agreement with Canadian firms, Ensol Systems and Enerfirm Technologies, for commercialization of off-grid fuel cell power solutions for remote applications in the cold, polar oil and gas fields in Northern Canada.
- Received a Certificate of Approval of the German Federal Army for use of the EMILY 2200 fuel cell in power supply applications of the German Armed Forces.
- For the fifth consecutive year, the readers of Europe's largest motorhome magazine "promobil" voted the EFOY COMFORT fuel cell under the top 3 of the best brands.
- EFOY COMFORT fuel cell generator was awarded a Special Mention in the Lifestyle category of the German Design Award by the German Design Council.

Toshiba

Toshiba was founded in 1939 by the merging of two companies, Shibaura Seisakusho (formerly Tanaka Seisakusho) and Tokyo Denki (formerly Hakunetsushua). In 1984, Toshiba operated an experimental 50 kW fuel cell power plant, which was the first and largest power plant in Japan at the time. Since the early 1990s the company has been conducting R&D on both active and passive DMFC technology, achieving several milestones and achievements and showcasing its technology in consumer electronics products before the official commercialization launch in Japan of its Dynario™ product in 2009. In 2001, Toshiba entered a joint venture with UTC Power to form Toshiba International Fuel Cells Corporation, now called Toshiba Fuel Cell Power Systems Corporation, focusing on PEM fuel cells for the Japanese market. Among the main products are residential PEM fuel cells and the PC25TMC 20 kW PAFC, developed since the early 1990s in partnership with UTC Fuel Cells. Toshiba Fuel Cell Power Systems Corp. has been developing a 1 kW residential fuel cell system since 2000 and, in 2003, was one of four companies selected by Osaka Gas to jointly develop residential PEM CHP systems as part of the ENE-FARM program (Panasonic is a partner in this venture). ENE-FARM sales began in 2009; a new ENE-FARM model was released in 2011 that features significant simplification of the fuel cell unit and miniaturization of core components.

Toshiba www.toshiba.co.jp	
Company Type	Public: TYO:6502, NASDAQ:TOSBF
Headquarters	Tokyo, Japan
Operations	• Tokyo, Japan - Toshiba Fuel Cell Power Systems • Kawasaki, Japan - R&D
Employees	Not reported
Fuel Cell Type	DMFC, PEM
Market Application	Consumer electronics, residential
Fuel Cell Manufacturing Capability	Not reported
NOTABLE 2012 NEWS: • Demonstrated a DMFC-powered cell phone at the CEATEC conference. The modified Toshiba T002 cell phone, which also includes a Li-Ion battery, can operate for 320 hours using the fuel cell and methanol fuel.	

UTC Power

Connecticut-based UTC Power, a unit of United Technologies Corp., developed and manufactured fuel cells for building, transit bus, automotive, space, and marine applications. The company was formed in 1958 when Pratt & Whitney Aircraft's Advanced Power Systems Group began to explore new power generation concepts. The company's fuel cells have provided electric power and drinking water for astronauts on every manned space flight since the Apollo program. Since the early 1990s, more than 300 UTC Power stationary fuel cell power plants have been installed in educational institutions, hospitals, manufacturing facilities, office buildings, and supermarkets, and 120 PureMotion power plants have been used in transit bus applications in Connecticut, California, and Europe.

In December 2012, United Technologies Corp. announced that it was selling its UTC Power unit to Oregon-based fuel cell manufacturer, ClearEdge Power. The transaction was finalized in early 2013.

Private Companies

Bloom Energy

Founded in 2001 and headquartered in Sunnyvale, California, SOFC manufacturer Bloom Energy shipped its first 5 kW field trial unit to the University of Tennessee, Chattanooga, in 2006. Following field trials in Tennessee, California, and Alaska, the first commercial 100 kW products were shipped to Google in July 2008. Since that time, Bloom Energy Servers have been deployed with customers such as Adobe, AT&T, Bank of America, Caltech, Coca-Cola, Cox Enterprises, eBay, FedEx, Google, Kaiser Permanente, Safeway, Staples, and Walmart. Bloom reports that its Energy Servers have generated more than 100 million kilowatt-hours of clean, reliable power for customers.

Bloom Energy www.bloomenergy.com	
Company Type	Private
Headquarters	Sunnyvale, California
Operations	• Sunnyvale, California - Headquarters and manufacturing facility • Newark, Delaware - Manufacturing facility under construction
Employees	Not reported
Fuel Cell Type	SOFC
Market Application	Stationary power
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 ACTIVITIES:

- In April 2012, broke ground for a new Bloom Energy Manufacturing Center in Newark, Delaware. The plant will be located on a 272-acre site formerly occupied by a Chrysler assembly plant, now owned by the University of Delaware.

ClearEdge Power

Founded in 2003 with operations on both coasts, ClearEdge Power is a global, privately held technology company that provides clean, scalable distributed power systems. ClearEdge Power is transforming power generation with innovative solutions that help customers reduce electricity bills, improve energy efficiency, and reduce carbon emissions. In December 2012, ClearEdge Power announced an agreement to acquire fuel cell manufacturer UTC Power, strengthening its position in the fuel cell industry and enabling the company to offer power systems that scale from 5 kW to multiple megawatts.

ClearEdge Power www.clearedgepower.com	
Company Type	Private
Headquarters	Sunnyvale, California
Operations	• Sunnyvale, California - headquarters • Other facilities located in Irvine, California; Hillsboro, Oregon; South Windsor, Connecticut
Employees	280
Fuel Cell Type	PAFC, PEM
Market Application	Stationary power generation
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 NEWS:

- Announced an agreement to acquire UTC Power.
- The ClearEdge5 fuel cell system received CSA certification and listing to ANSI/CSA Americas FC-1 (industry standards for safety and performance).

Horizon Fuel Cell Technologies

Singapore-based Horizon Fuel Cell Technologies was founded in 2003 and currently owns five international subsidiaries, including a new subsidiary in the United States. Currently, Horizon is the world's largest micro-fuel cell producer and the largest producer of PEM fuel cell stacks below 1,000 W. Horizon's technology platform consists of fuel cells and their materials, hydrogen supply, and hydrogen storage. Today, Horizon produces compact, lightweight PEM fuel cells at various performance levels, and also delivers hydrogen storage and on-site hydrogen generation solutions for multiple applications.

The company began by commercializing small and simple products while preparing for larger and more complex applications. In 2006, Horizon launched its "H-Racer" toy fuel cell car, named by TIME Magazine as one of the best inventions of the year. As a result the company began commercial sales of various micro-fuel cells for numerous science education kits which have shipped in the hundreds of thousands of units to over 60 countries. In 2009, the company started Horizon Energy Systems, a separate company in Singapore, which applies its ultra-light fuel cell technologies for customers in aerospace and defense. In 2008, Horizon unveiled the first version of its Hydropak, a portable fuel cell power system capable of producing 60-100 W using ultra-light 150 watt-hour (Wh) chemical hydride cartridges, as well as the first version of a small 2 W micro-fuel cell power extender for consumer devices called MiniPAK, using 12 Wh metal hydride cartridges. In 2010, Horizon began work on a new easy to use and simplified version of the Hydropak with proprietary and lower cost cartridge technologies.

Horizon Fuel Cell Technologies www.horizonfuelcell.com	
Company Type	Private
Headquarters	Singapore
Operations	• Singapore - global headquarters • San Francisco, California - regional headquarters • Prague, Czech Republic - regional headquarters
Employees	120
Fuel Cell Type	PEM
Market Application	Consumer electronics, portable power, educational, stationary power, military, electric vehicles, aerospace
Fuel Cell Manufacturing Capability	500,000 micro-fuel cells per year One thousand 100 W-5 kW fuel cell stacks per year

NOTABLE 2012 NEWS:

- Announced global fuel cell product integration platform with U.K.-based Arcola Energy Ltd. The partnership is aimed at providing deployment, customization, and integration support to a wide range of companies launching Horizon fuel cell products in the U.K.
- Horizon and Fab Lab Store entered into a global distribution and co-development agreement for a new "Maker Development Kit" named H2MDK. The product is a DIY solution created for product inventors that uses Horizon's hydrogen storage components.
- Horizon announced REI would carry its micro-fuel cell products in North America, including MINIPAK.

IdaTech – Acquired by Ballard in 2012

In July 2012 Ballard Power Systems (NASDAQ: BLDP) announced a deal to acquire assets from IdaTech, including its fuel cell product lines for backup power applications and distributor and customer ties, as well as a license to intellectual property. IdaTech's methanol products demonstrated strong commercial value to customers in Indonesia, Mexico, and Vodacom, where they replaced diesel generators due to frequent and extended run times. Payment for the assets was made through the issuance of $7.7 million of Ballard common shares.

Intelligent Energy

U.K.-headquartered Intelligent Energy was founded in 2001 after acquiring APS, a Loughborough University spin-off company, and subsequently acquired U.S.-based Element One Enterprises (2003) and MesoFuel Inc. (2004), both now part of the company's Long Beach, California operation. Intelligent Energy partners with global companies that focus on the automotive, stationary power, and consumer electronics markets. Intelligent Energy, with the Suzuki Motor Corporation, built the Burgman Fuel Cell Scooter, the first fuel cell electric vehicle to achieve European Whole Vehicle Type Approval and supplied the fuel cell to Boeing who used it to power the world's first manned fuel cell aircraft. Today, the company has over 23 years of R&D experience and 440 patents (granted and pending).

Intelligent Energy www.intelligent-energy.com	
Company Type	Private
Headquarters	Loughborough, United Kingdom
Operations	• Loughborough, UK - headquarters • Other facilities located in Long Beach, California; Japan; India
Employees	Over 300
Fuel Cell Type	PEM
Market Application	Aerospace, defense, distributed power, generation portable power, motive, hydrogen generation
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 NEWS:

- Deloitte ranks Intelligent Energy in its Fast 500 list of high growth technology companies for 2012. Deloitte also names Intelligent Energy among the UK's fastest growing technology companies in 2012.
- Intelligent Energy is ranked 55th among the fastest growing private technology, media and telecom companies in the UK, and is among the top nine British companies fuelling the development of environmentally-friendly technologies.
- Signs a Statement of Intent with Indian Oil Corporation to develop and deploy fuel cell systems in India using hydrogen produced by Indian Oil.
- Announced a partnership with Ricardo Plc. to provide customers with an integrated design, engineering and implementation capability of fuel cell electric vehicles.
- Announced the creation of a joint venture company with Suzuki Motor Corp., called SMILE FC System Corporation, to develop and manufacture fuel cell systems for multiple industries.
- Became a founding member of UKH_2Mobility, a government and industry group working to accelerate the commercial roll out of hydrogen vehicles in 2014/15.

Microcell Corporation

Microcell Corporation began operation in 2000 after receiving initial seed funding from Advanced Energy Corporation. After developing prototypes, Microcell received $2 million in funding in 2001 from the National Institute of Standards and Technology Advanced Technology Program, and subsequent investors and partners have included Pepco Holdings, Inc., Progress Energy, American Electric Power, Dominion, Duke Energy, and the North Carolina Electric Cooperatives. The company's Microcell™ product was an extrusion-based PEM fuel cell technology that operates on a micro-tubular platform, for markets that included data centers, disaster recovery, utility sub-stations, and telecom sites. Microcell manufactured and sold packaged hydrogen-fueled PEM fuel cells in the 1 to 5 kW size range and power plants of in the range 50 to 100 kW and higher.

Microcell officially ceased operations as of December 31, 2012.

Nedstack PEM fuel cells

Nedstack is a PEM fuel cell stack provider for system integrators who deliver energy systems to the telecom, rail, and utilities industries. Nedstack also builds PEM power plants to generate electric power and heat from hydrogen produced in chlor-alkali plants. The company originated from Netherlands-based AkzoNobel Research, which started PEM fuel cell development in 1997. Nedstack was founded in 1998 when seven development engineers got the opportunity to take over AkzoNobel's PEM activities. Over 1,000 Nedstack fuel cells are in commercial operation world-wide, mostly in backup power applications. Some have been in use since 2006.

Nedstack PEM fuel cells www.nedstack.com	
Company Type	Private
Headquarters	Arnhem, The Netherlands
Operations	Arnhem, The Netherlands – headquarters, manufacturing
Employees	More than 50
Fuel Cell Type	PEM
Market Application	Stationary power, backup power, material handling, buses
Fuel Cell Manufacturing Capability	3,000 stacks per year

NOTABLE 2012 NEWS:

- Updated the progress of its 1-MW "PEM Power Plant" fuel cell system installed at Solvay's chlorine plant near Antwerp, Belgium. Performance has been "Impressive," with electrical efficiency of 50%, total efficiency of 80% and availability of 99%.

Nuvera Fuel Cells

Nuvera is a technology and product development company focusing on the commercialization of distributed hydrogen production systems and fuel cell power systems. Nuvera's world headquarters are located in Billerica, Massachusetts, where the company employs 120 people. Nuvera Fuel Cells Europe, a wholly-owned subsidiary, is based in Milan, Italy and has 14 employees. Nuvera Fuel Cells (USA) is ISO 9001:2008 certified.

Founded in 2000, Nuvera has been privately held by industrial investors with a strategic interest in the development of the business. Hess Corporation, a New York based integrated energy and oil company, consolidated its position as the sole owner of Nuvera in 2008.

Nuvera's personnel base includes 70 scientists and engineers, and the company has managed over $250 million to achieve commercial launch of hydrogen and fuel cell products since inception. The company has an accomplished track record designing, fabricating, testing, and deploying fuel processors and PEM fuel cell stacks and owns extensive intellectual property including 35 patent families and 96 additional patents pending.

Nuvera is located in an 111,000 sq. ft. state-of-the-art development and manufacturing facility in Billerica, Massachusetts with over 20,000 sq. ft. devoted to prototyping, fabrication, and laboratory facilities supporting fuel cell development.

Nuvera Fuel Cells www.nuvera.com	
Company Type	Private
Headquarters	Billerica, Massachusetts
Operations	• Billerica, Massachusetts - headquarters, production • San Donato, Italy - Nuvera Fuel Cells Europe, SrL • Osio Sopra, Italy - Fuel Cell Qualification Laboratories
Employees	134 worldwide
Fuel Cell Type	PEM
Market Application	Fuel cells for mobility applications (industrial, on-road, aerospace), hydrogen generation and fueling
Fuel Cell Manufacturing Capability	3,000 units per year

NOTABLE 2012 NEWS:

- Launched fuel cell vehicle program in Massachusetts with Toyota.
- Received contract from Pacific Northwest National Laboratory to develop fuel cell APU for refrigerated truck.
- Created three new Senior Management positions to help implement the company's go-to-market strategy focused on commercial-scale hydrogen products for mobility - Vice President (VP) of Organizational Effectiveness, VP of Product Development and Manufacturing Operations, and VP of Commercial Operations.

Oorja Protonics

Oorja Protonics, founded in 2005, produces direct methanol fuel cell systems for material handling equipment. The company's OorjaPac fuel cell product operates as an on-board battery charger for material handling vehicles. OorjaPac features on-board sensors that keep the vehicle's battery at a constant state of charge, eliminating the need for battery swapping and rapid charging. Oorja Protonics also offers the OorjaRig™, a refueling system that stores and delivers methanol to the OorjaPac™ on-board charging system that is designed for indoor use in commercial and industrial environments. Oorja's customers include Golden State Foods, Martin-Brower, Nissan, Super Store Industries, Unified Grocers, and U.S. Foodservice.

Oorja Protonics http://oorjafuelcells.com	
Company Type	Private
Headquarters	Fremont, California
Operations	Fremont, California – headquarters, manufacturing
Employees	30
Fuel Cell Type	PEM
Market Application	Material handling equipment
Fuel Cell Manufacturing Capability	2,000 – 3,000 units per year, 4-6 MW per year

NOTABLE 2012 NEWS:

- Became the approved service provider for UniPro Foodservice, Inc., the largest foodservice distribution cooperative in the U.S., which is comprised of more than 650 member companies.

ReliOn, Inc.

ReliOn develops and markets a range of modular, fault-tolerant, PEM stationary fuel cells for emergency and backup power requirements, uninterruptible power supplies, digital power needs, and a variety of off grid power requirements. Through 2012, ReliOn sold more than 4.9 MW of fuel cells to over 1,550 customer sites in the wireless and wireline telecommunications, transportation, utility, and government sectors throughout the U.S., Europe, South America, Australia, Africa, and Asia. Based in Spokane, Washington, the company was incorporated in 1995 as Avista Laboratories, Inc., and renamed ReliOn, Inc. in 2004. The company's products range in size from 175 W to 2.5 kW and are configured to meet power requirements up to 20 kW.

ReliOn, Inc. www.relion-inc.com	
Company Type	Private
Headquarters	Spokane, Washington
Operations	Spokane, Washington - R&D, product development, sales and marketing, administration
Employees	47
Fuel Cell Type	PEM
Market Application	Backup power
Fuel Cell Manufacturing Capability	Scalable as needed through contract manufacturers

NOTABLE 2012 NEWS:

- In June 2012, announced it has delivered more than 4.3 megawatts of fuel cell products to customers in 42 U.S. states and 34 countries.
- Announced collaboration with Hy9 on an integrated methanol reformer for use with ReliOn's fuel cell products, including its E-series fuel cell systems.
- Announced a new patent issuance that supports lower cost fuel cell architecture to ReliOn's E-series product lineup.
- Announced two new fuel cell products: the E-1000x (1 kW) and E-2200x (2.2 kW). The products are intended to serve high duty cycle grid-support in areas with unreliable or nonexistent electrical grid.
- Chosen by AlwaysOn as one of the GoingGreen Silicon Valley Global 200 winners, which signifies leadership among its peers and game-changing approaches and technologies that are likely to disrupt existing and entrenched players in green technology.

Ultra Electronics, AMI

Adaptive Materials, developer and manufacturer of portable, propane-powered SOFCs, was acquired by UK-based Ultra Electronics Holdings plc. in 2011. Ultra Electronics Adaptive Materials Inc. (Ultra Electronics, AMI) will continue to develop and manufacture fuel cell systems from its current Ann Arbor, Michigan facility. In recent years Ultra Electronics, AMI has been awarded over $45 million from the U.S. Department of Defense and other research agencies. Ultra Electronics' products are the RoAMIo Defender and the RoAMIo Performer. The Defender series, designed for military applications, includes a 250-watt unit for unmanned ground and aerial vehicles, and 300-watt fuel unit for more general field use. The Performer is a 300-watt fuel cell for commercial use, specifically, remote industrial use such as backup power for transportation systems, surveillance equipment and remote monitoring.

Ultra Electronics AMI www.ultra-ami.com	
Company Type	Private
Headquarters	Ann Arbor, Michigan
Operations	Ann Arbor, Michigan – headquarters, R&D, manufacturing
Employees	Not reported
Fuel Cell Type	SOFC
Market Application	Portable power
Fuel Cell Manufacturing Capability	Not reported

NOTABLE 2012 NEWS:

- The propane-powered RoAMIo D300 product is no longer restricted by International Traffic in Arms Regulations (ITAR), allowing the unit to be sold commercially and exported without an export license.
- The *Army Times* magazine rated Ultra Electronics AMI's fuel cells as "4 Star" gear for soldiers in the field, citing the fuel cell's silent operations and long power duration as factors influencing the positive rating, as well as the fuel cell's use of propane — a fuel available anywhere in the world.

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For more information, please visit:
hydrogenandfuelcells.energy.gov

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