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# Hybrid Electric Vehicles & Competing Automotive Powerplants

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US Industry Study with Forecasts to **2009 & 2014**

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Study #2025 | January 2006 | \$4200 | 291 pages

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*Diesel engines and hybrid-electric powerplants will begin to take US market share away from spark ignition internal combustion engines through 2009.*

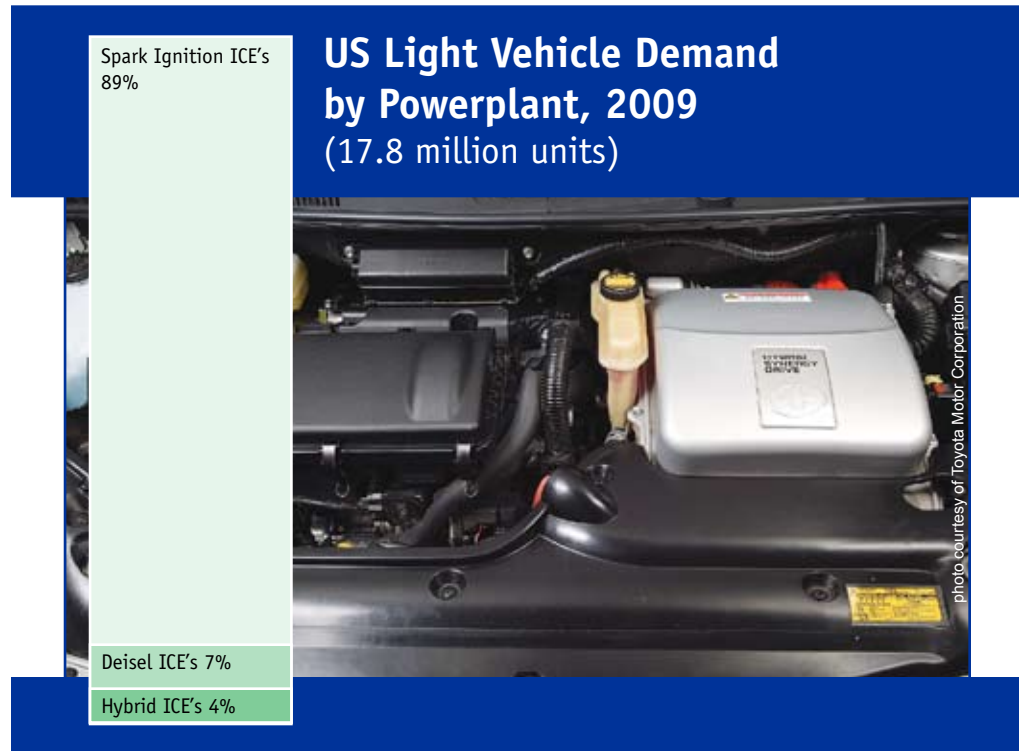
## Spark ignition ICEs to lose market share yet remain dominant

While overall sales of light vehicles in the US are forecast to grow less than one percent annually through 2009, there will be a significant shift in the product mix of powerplants used, with diesel engines and hybrid-electric powerplants beginning to take share away from spark ignition internal combustion engines. The fuel price spike that occurred in 2005 created new interest in fuel-efficient powertrain technologies, which has boosted demand for hybrid-electric vehicles and, to an extent, for diesel engines. Fuel cells remain a more distant promise due to technology hurdles and infrastructure challenges.

Despite rapid gains in alternative powerplant types, the conventional spark ignition internal combustion engine (ICE) will remain the dominant powerplant technology in the US throughout the forecast period. The spark ignition ICE's continued ability to cost-effectively meet tighter emissions standards yet provide high levels of power and driveability will ensure its position in the marketplace. Even so, continued consumer demands for improved fuel economy are causing automakers to seek out efficient new technologies. Furthermore, hybrid-electric vehicles (HEVs) offered in the US to date have all utilized some form of spark-ignition technology, thus helping to maintain the dominance of this powerplant type.

## Low-sulfur fuels, more vehicle models to help boost diesel ICEs

The diesel ICE has recently emerged as a legitimate substitute for the spark ignition engine in the US light vehicle market both from a business and a regulatory perspective. The



tremendous success of the technology in Europe, where it is on the verge of capturing 50 percent of the light vehicle market, amply demonstrates the advances made in light diesel direct injection technology in the past decade. Growth will be robust, due in part to the introduction of low-sulfur fuels (scheduled for late 2006), which will make meeting new emissions standards more feasible for light vehicles. More OEMs, including DaimlerChrysler and BMW, are introducing diesel-powered light vehicles in the US market in anticipation of rising demand.

## Hybrid-electric ICEs to outpace other powerplants

The market for hybrid-electric ICEs will expand significantly from a relatively small base in 2004. Hybrid-electric ICEs feature adapted internal combustion engines in tandem with electric motors to increase fuel effi-

ciency and reduce emissions while providing performance similar to a conventional spark ignition engine. Demand is being driven both by increased concerns regarding fuel prices and the additional performance HEVs can offer in acceleration. HEV technologies have already become quite robust in terms of reliability and durability, despite their comparatively brief presence in the market.

Two types of hybrids are currently being developed: full hybrids, with large high voltage battery packs such as those introduced by Toyota and Honda in the US market; and mild hybrids, which provide less electric power to operate the vehicle but can be more easily integrated into existing ICE drivetrains and are more cost effective. Cost disparities between HEVs and conventional light vehicles -- currently estimated at between \$600 and \$4,000 per vehicle, depending on type of hybrid technology used -- are expected to decline significantly as production increases.

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## Samples Pages, Tables & Charts

### HYBRID-ELECTRIC INTERNAL COMBUSTION ENGINE

#### Mild Hybrid-Electric Internal Combustion Engines

Mild hybrid internal combustion engines used in light vehicles in the United States will witness explosive growth through 2009, with only a few thousand mild hybrid systems were available in 2004. Volumes will reach 1.5 million units by 2009. The mild hybrid technology is the industry's expected next generation technology. 12-volt batteries are used, which are powered by the engine. Mechanical issues surrounding the 42-volt system may limit its penetration through the end of the decade. Conversely, mild hybrid technologies could themselves migrate into the 42-volt role on an incremental basis, with additional electrical systems being integrated with and powered by the hybrid technology.

**PRODUCT TYPES**  
Text sections explain and support each table's data and projections

Depending on design, mild hybrids feature many of the same systems as full hybrids, including advanced power management systems, inverters and high voltage battery packs, which are described in previous sections. The integrated starter/generator (ISG) system may also be used in full hybrid application, but is closely associated with mild hybrids and is the technology that appears to differentiate the mild hybrid from the more generic 42-volt technologies that are due to appear in the marketplace in the future. ISG is far more efficient than a conventional alternator and more powerful than a conventional starter. The ISG unit can be installed between the engine and transmission and linked directly to the crankshaft, or be mounted to the front of the engine and driven via a serpentine belt. The ISG can replace both the starter motor and the alternator, though some designs retain conventional starter systems, a redundancy that could ultimately disappear as confidence grows in the ISG technology. Continued work in reducing the width of the ISG makes the technology easier to retrofit as part of traditional ICE powertrains.

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TABLE VI-3

DIESEL ENGINE LIGHT VEHICLE DEMAND  
(000 units)

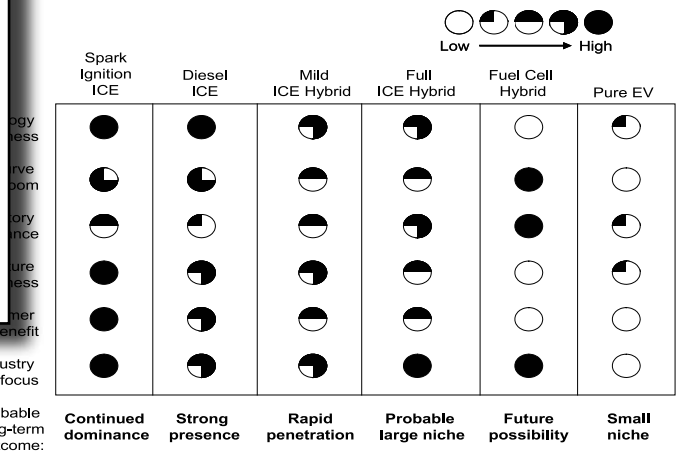
Item	1994	1999	2004	2009	2014
Light Vehicle Sales	15075	17000	16070	17750	18700
% equipped					
Light Vehicles w/Diesel Engines	2				
— Direct Injection	1				
— Indirect Injection					
Passenger Car					
Light Truck	2				

#### TECHNOLOGY

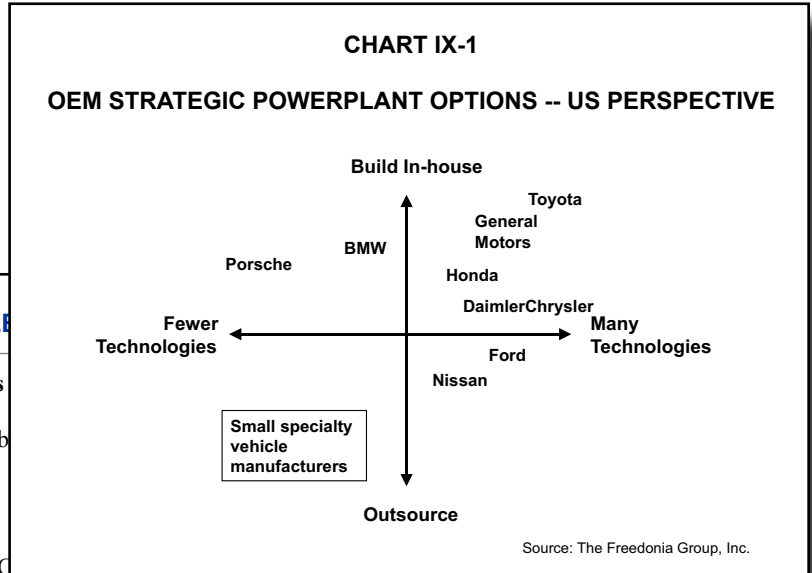
Technologies assessed include historical data plus demand forecasts to 2009 and 2014 for internal combustion engines, hybrid-electric ICE powerplants and fuel cell vehicles

CHART V-2

LIGHT VEHICLE POWERPLANT TECHNOLOGY ASSESSMENT  
(NEXT DECADE)



## Sample Profile & Chart



### COMPANY PROFILE

**Ballard Power Systems**  
 4343 North Fraser Way  
 Burnaby, British Columbia  
 Canada  
 604-454-0900  
<http://www.ballard.com>

Ballard Power Systems Corp.  
 15001 Commerce Drive North  
 Dearborn, MI 48120  
 313-583-5980

Revenues: US\$64 million  
 US Revenues: US\$50 million  
 Employment: 980

Key Products: powerplants

Ballard Power Systems Corp. is a commercialization and related power generation, Transportation segment, 19.6-percent and 19.6-percent owned by DaimlerChrysler AG (Germany) and Ford Motor Company (Dearborn, Michigan), respectively.

The Company is active in the hybrid and competing automotive powerplant industry through the Transportation segment, which generated revenues of US\$64 million in 2004. Of the segment's total 2004 revenues, products accounted for US\$50 million and engineering service and other revenues represented US\$14 million. Through the Transportation segment, Ballard manufactures PEM fuel cell products and electric drive systems for passenger cars, buses and vans, in addition to fuel cells for residential cogeneration applications.

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### COMPANY PROFILES

**Products & Facilities** — For liquid fuel cells, Ballard Power Systems Corp. produces fourth-generation Ballard Mark 902 PEM fuel cells. These fuel cells offer a continuous power output of 85 kilowatts (kW) and feature Ballard's proprietary flow field plates for electrical and thermal management. The MARK 902 PEM fuel cells are designed for use in stationary power applications, feature stack sizes ranging from 4 to 21 kW.

Ballard manufactures fuel cells at its Burnaby, British Columbia, Canada development operations for fuel cell and fuel cell assembly and testing. In the US, the Company is active through Ballard Power Systems Corporation, which makes high-quality car fuel cells, electrical and other industries.

### Selected Cooperative Agreements

Ballard Power Systems Corp. participates in the hybrid and competing automotive powerplant industry through a vehicular fuel cell alliance with Ford and DaimlerChrysler, and through membership in the California Fuel Cell Partnership. The alliance, which extends through 2021, was created for the development and commercialization of PEM fuel cells, fuel cell engines and fuel cell electric drive systems for vehicular use. Under the terms of the alliance,

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### COMPANY PROFILES

The Profiles Section analyzes 36 firms active in this US market. The profiles are a sampling or cross-section of the types of companies involved in the industry.

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**OTHER STUDIES**

**Automotive Aftermarket in China**

The aftermarket for light vehicle components and parts in China will grow 17.9% annually through 2011. Gains will be driven by the dramatic increase in the light vehicle park and increasing aftermarket spending per vehicle. Mechanical products will remain the largest segment while electronics grow the fastest. This study analyzes the 33.7 billion automotive aftermarket in China, with forecasts for 2011 and 2016 by product and service performer. It also evaluates market share and profiles major players.

#2262 ..... 12/2007..... \$4900

**World Fuel Cells**

Global fuel cell spending (R&D, investment, sales) will grow 15% yearly through 2011. Portable electronics will be the fastest growing commercial use while electric power generation will stay the largest. Proton-exchange membrane fuel cells will remain dominant over other chemistries. This study analyzes the \$5.2 billion world fuel cell industry to 2011 and 2016 by product, chemistry, application, world region and for 14 countries. It also reviews technology, evaluates market share and profiles major players.

#2194 ..... 05/2007..... \$5500

**Diesel Engines**

US demand for diesel engines will grow 3.8% annually through 2011. Best opportunities in the dominant motor vehicle market will be found in light-duty trucks, with the much smaller passenger car segment also faring very well. Off-highway diesel engines will experience slowing but still robust demand as new emissions regulations phase in. This study analyzes the \$16.6 billion US diesel engine industry to 2011 and 2016 by product, material and market. It also details market share and profiles major firms.

#2171 ..... 03/2007..... \$4400

**Batteries in China**

Demand for batteries in China will grow 13.2% annually through 2010. Gains will be driven by the emergence of electric bicycles and strong domestic consumer demand for battery-powered products. Alkaline and lithium batteries will be the fastest growing primary type while rechargeable lithium batteries will pace the secondary battery segment. This study analyzes the ¥59 billion Chinese battery industry for 2010 and 2015 by product and market. It also evaluates market share and profiles leading competitors.

#2151 ..... 02/2007..... \$4900

**World Hybrid-Electric Vehicles**

Global demand for hybrid-electric vehicles (HEVs) will grow 20% annually through 2010. Gains for these fuel-efficient vehicles will be driven by erratic fuel prices, increased emissions regulations and lowering HEV cost disparities. The US, Western Europe and Japan will remain the top markets, with China catching up fast. This study analyzes the \$2.8 billion world HEV industry to 2010, 2015 and 2020 by type, segment, world region and for 12 countries. It also evaluates market share and profiles major players.

#2108 ..... 10/2006..... \$5500

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