May 28, 2008

Japan: Automobiles

We expect the coming hybrid era to bring earnings growth

The hybrid decade is coming

We expect tougher environmental regulations and soaring crude oil prices to bring changes to the automobile industry. Fuel efficiency measures for conventional gasoline and diesel engines are near their limit, necessitating a shift to the next-generation power train. The electric car is the best solution to pressing environmental and resource issues, but it will take over ten years to develop the required technology. As mass production brings costs down, we project hybrid car demand will grow at an annual rate of roughly 30% until 2020.

Hybrid auto sales to rise sharply in 2009

We see 2009 as a big year for hybrids, with sales expanding rapidly. Toyota (7203.T, Buy) plans to halve hybrid unit costs for the next Prius. The image of hybrids has been one of low profitability, with little potential for growth. We believe this is about to change.

Toyota in the lead in hybrid experience

Toyota is the biggest player in the hybrid market. We think Denso (6902.T, Neutral), which makes basic components, and Honda (7267.T, Neutral), which is in hot pursuit of Toyota, may also grow earnings on this business. As cost cuts feed in and auto makers are able to set higher prices on the back of rising crude oil prices, we think hybrids could account for 5-10% of consolidated operating profits at both Toyota and Honda by 2010. US and European auto makers, traditionally lukewarm on hybrids, are getting serious on development. In terms of scale, sales, and technology, however, we think Toyota and Honda remain the companies to beat.

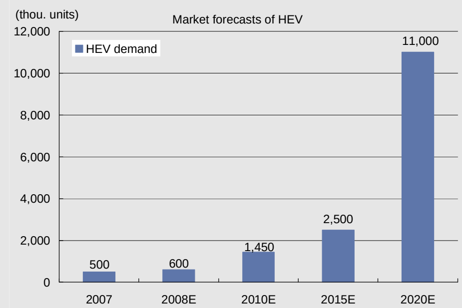
Further alliance building on environment-friendly vehicles

We think there will be further alliance building in the auto sector, not just for hybrid technology but for all forms of environment-friendly vehicles. Fuji Heavy Industries (7270.T, Neutral) has solicited additional investment from Toyota and aims to strengthen joint development.

Battery development may change the auto industry map

Battery development will be key to progress in hybrid and electric cars. Development of lithium-ion batteries is proceeding toward practical application in 2010. The winners and losers in this area are not yet clear.

WE EXPECT STRONG HEV MARKET GROWTH BY 2020



Source: Company data, Goldman Sachs Research estimates.

AUTOS COVERAGE: RATINGS AND TARGET PRICES

Code	Company	Rating	Target price
7203	Toyota	Buy	5,800
7267	Honda	Neutral	3,000
7201	Nissan	Neutral	850
6902	Denso	Neutral	3,600
7211	MMC	Sell	100
7261	Mazda	Neutral	450
7262	Daihatsu	Neutral	1,250
7269	Suzuki	Neutral	2,900
7270	FHI	Neutral	510
7272	Yamaha Motor	Sell*	1,700
7202	Isuzu	Buy*	600
7205	Hino	Neutral	620

Note: * = Conviction List. Coverage view is Cautious. Target prices are calculated using our FY3/09 ROIC calculations (FY12/08 for Yamaha) and relative valuations (excluding Mitsubishi and Fuji Heavy). Mitsubishi's target price is based on maximum profits and relative valuation. Fuji Heavy is based on the market value of Toyota's holding. Risks include forex and input prices. Denso is covered by Yuki Kimura. Source: Company data, Datastream, Goldman Sachs Research estimates.

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Overview: Next ten years the hybrid decade; environmental technologies a Japanese strength

We expect the global wave of environmental regulations, combined with sharply rising crude oil prices, to trigger a major change in automotive sector product strategies. With improvements in fuel efficiency for traditional gasoline and diesel internal combustion engines approaching their limits, the transition to next-generation power trains can wait no longer. Assuming auto demand does not disappear, electric automobiles are one way to solve environmental problems and resource demand, but building up the required technologies will take at least another 10 years. From 2010 until 2020, we expect to see growth in the market for hybrids, where production volume growth on strengthened environmental regulations is enabling cost reductions. We think a 180-degree turnaround from the low-margin, low growth-potential image of the hybrid automobile may be possible as hybrids start to make substantial contributions to automaker earnings. Toyota is the key player in this segment.

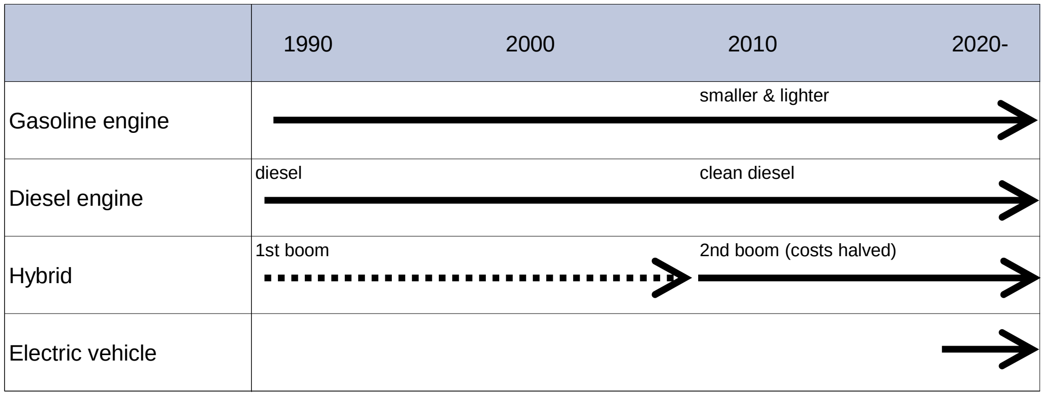
Strengthened environmental regulations, rising oil prices increasing demand for green autos

Automakers are doing their best to meet the EC's 2012 CO2 emission target of 130g per kilometer (maker average). However, this target is more than 30% below the simple average achieved in 2006, and is difficult to achieve based purely on improvements to traditional gasoline and diesel internal combustion engines. Our global oil research team now thinks it increasingly likely that crude oil will reach \$150-\$200 per barrel over the next 6-24 months. We expect consumers' growing interest in hybrid vehicles to give manufacturers greater pricing power.

Next ten years the hybrid decade

Although we think the electric automobiles are the most realistic environmentally friendly technology, the development of that technology may take at least another decade (see Exhibit 1). We focus on growth in the hybrid segment as a stopgap in the transition to electric cars. Hybrid vehicles are the most advanced in terms of actual usage, and do not suffer from distance limitations, one disadvantage of electric cars. In addition, the batteries, motors, and power control units used in hybrids are all key technologies essential to the development of electric cars. Clean diesel technologies, the focus of European manufacturers, are also competitive in terms of improving fuel consumption. However, when considering the ultimate transition to electric cars, we think manufacturers who can more quickly begin mass-producing the batteries and motors that are the key elements in next-generation power trains will have a distinct advantage.

Exhibit 1: Hybrids the most realistic option for the next decade
Environmental compliance by power train



Source: Goldman Sachs Research estimates.

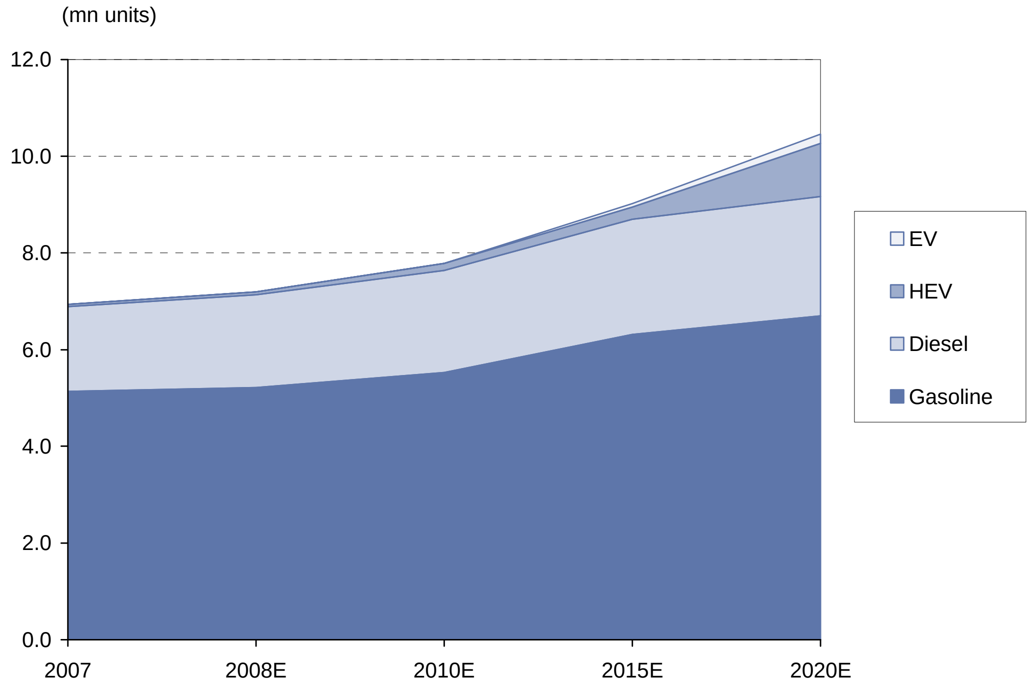
Hybrids to enter second growth phase in 2009

We expect 2009 to be a big year for the introduction of hybrid models, and look for rising concern over the environment to trigger demand growth. Specifically, we expect Toyota to release a third-generation Prius as well as another pure hybrid and the FT-HS. In developing the new Prius, Toyota looks to halve unit costs relative to the current model, which could change the price image of hybrid vehicles. Honda also plans to introduce its first pure hybrid model, the IMA Car. European and US makers are starting to enter this market, but we think it will take other manufacturers some time to catch up to Toyota and Honda in terms of technology and sales volumes.

Some estimates call for hybrid vehicle demand of over 10 mn units by 2020

The hybrid market totaled roughly 600,000 units in FY2006, less than 1% of the global automobile market. Nevertheless, we expect the market to grow to 1.45 mn units by 2010 and to 2.5 mn units by 2015 (see Exhibit 2). Although it is difficult to forecast the 2020 market this far ahead of time, some of the manufacturers now in the hybrid business are making capital investments and setting up product development structures in anticipation of the market exceeding 10 mn units by then. We expect the hybrid segment to grow to more than 10% of global auto sales.

Exhibit 2: Hybrids may reach 10% of sales in 2020
Global auto sales estimates by power train



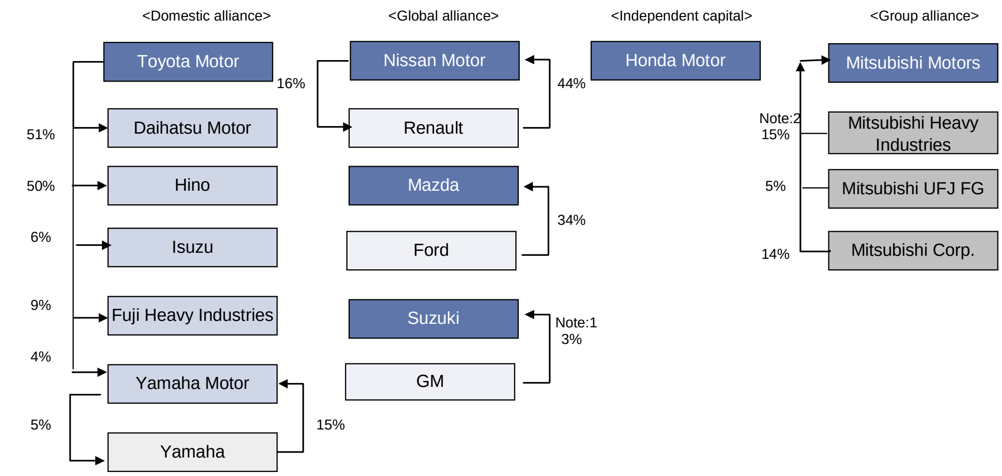
Source: VDA, Global Insight, Automotive Technology, Goldman Sachs Research estimates.

Toyota's hybrid track record dominates. We expect further industry consolidation

Although Toyota is the most important player in the hybrid vehicle market, we also see opportunities for earnings growth at Denso, a developer and manufacturer of core components, and Honda, which is in hot pursuit of Toyota. We estimate Toyota will have an over-60% share and Honda over 20% of the hybrid vehicle market in 2010. We expect hybrids to account for 9% of Toyota's and 9% of Honda's consolidated sales volume. Assuming cost reductions, benefits from mass production, and a shift of pricing power to manufacturers, we think hybrids may account for 5-10% of both companies' total profits in 2010. We also see the possibility in the not-too-distant future of the hybrid's image changing as a result of the benefits of mass production. Rather than being viewed as low-margin and low growth-potential, we think hybrids might be seen as the earnings driver for automakers.

We think there could be another round of consolidation in the automotive industry aimed at environmental compliance, not necessarily limited to hybrid technologies. Fuji Heavy Industries solicited additional investment from Toyota in 2008, and the two continue to strengthen joint development capabilities (see Exhibit 3).

Exhibit 3: Growth in hybrids could bring further changes to industry alliances
Capital tie-ups among Japanese automakers (as of May 2008)



Notes: (1) Suzuki continues to buy back shares held by GM, and is looking for ways to dispose of the shares while considering GM's financial position. (2) Has invested in both common shares and preferred shares.

Source: Company data.

Development of lithium-ion batteries the key

The development of batteries is key to growth in demand for both hybrids and electric cars. Hybrid vehicles currently use nickel-metal hydride (NiMH) batteries, but we expect lithium-ion batteries to be on board in 2009-10. The development of lithium-ion batteries, now being pursued in Japan by companies including Panasonic EV Energy, Sanyo Electric, Automotive Energy Supply (AESC), GS Yuasa, and Hitachi Vehicle Energy, is still in the early stages, making it difficult to separate the winners from the losers just yet. We view Panasonic EV Energy as leading the pack in battery technology both in volume production and technology development.

Stock picks: Toyota's hybrid track record dominates; Honda in hot pursuit

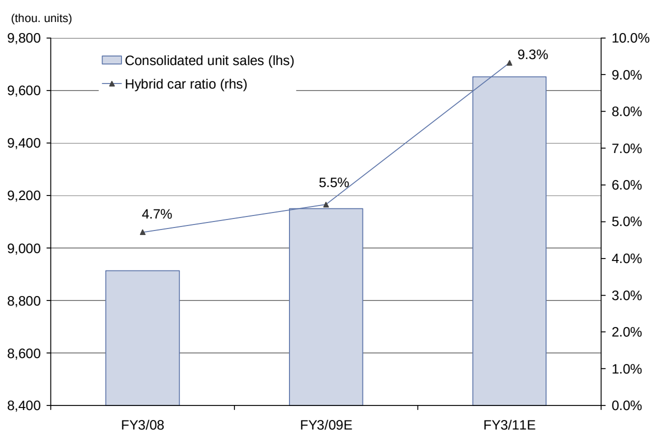
Toyota (7203.T, Buy): Hybrid track record dominates

Earnings impact

Toyota's hybrid sales volume of roughly 400,000 units in FY3/08 accounted for 5% of consolidated sales, and we expect this to grow to 9% by 2010 (see Exhibit 4). Since it began selling the first-generation Prius nearly 10 years ago, hybrids have grown into a critical segment from a product strategy perspective.

We think 2009 may prove to be a turning point in Toyota's hybrid strategy (see Exhibit 5). Development of the third-generation Prius targets a halving of unit costs, which would make it a very attractive product. Demand for hybrids is growing on the sharp rise in crude oil prices; US Prius inventories stood at only seven days in April 2008, versus around 60 days normally. Although hybrids are viewed as low-margin models, we think price hikes and cost reductions may allow them to generate 10% of Toyota's consolidated operating profits by 2010.

Exhibit 4: Hybrids approaching 10% of sales
Hybrids as a percentage of Toyota's consolidated sales volume



Source: Company data, IRC, Goldman Sachs Research estimates.

Exhibit 5: Further strengthening of product lineup in 2009
New hybrids planned by Toyota (our estimates)

	Toyota
2009	Prius (3rd generation) SAI (Hybrid-only model) FT-HS (V6, 3.5l engine)
2010	Corolla hybrid Vitz hybrid Plug-in hybrid (Lithium ion battery)
2010-	1/X・hybrid (44km/l) 1mn annual unit sales of hybrid models

Source: Company data, IRC, Goldman Sachs Research estimates.

Challenges

We think Toyota's hybrid strategy faces a number of challenges, including speeding up production volume expansion, deciding whether to enter the market for mild hybrids (explained later), and establishing superiority in battery development versus competitors.

Growth in production volume must adequately meet rising consumer demand. For hybrids to become a de facto standard, Toyota may have to consider supplying units to rivals. Toyota is targeting annual sales volume of 1 mn units early in the 2010s, and we think further increases in production capacity will be necessary to achieve this.

Honda and manufacturers in Europe and the US are going after the mild hybrid market. Although the mild versions can be produced more cheaply than Toyota's strong hybrids, they provide less in the way of improved fuel efficiency and offer less of the technology needed for large vehicles. Honda plans to introduce a mild hybrid, the IMA Car, in 2009, and depending on where it sets the price, we think it could outstrip Toyota's models and develop into a de facto standard. It may make sense for Toyota to also offer a mild hybrid in the compact segment to give customers another choice.

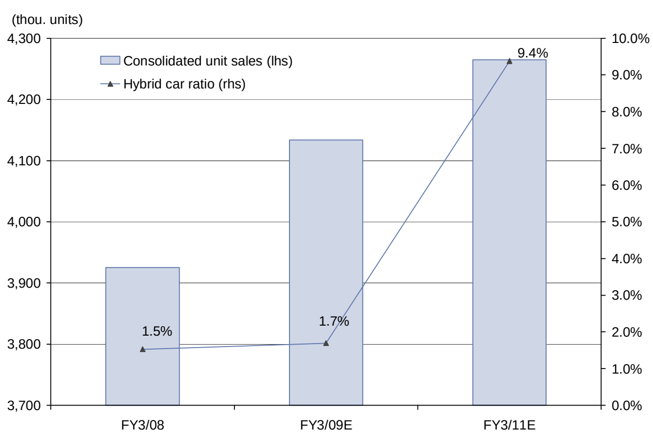
Battery technology is rapidly evolving. However, it is still in the early development stages, particularly for lithium-ion, and it is not yet clear which battery manufacturers will prevail. Toyota is moving fast in the development of lithium-ion batteries through Panasonic EV Energy (owned 60% by Toyota and 40% by Matsushita Electric Industrial), and expects to build annual production capacity of 200,000-300,000 lithium-ion batteries by 2010. On the other hand, numerous challenges to raising the durability and safety of lithium-ion remain, including the cathode materials and state of charge (SOC) settings. We will focus on whether Toyota can develop in-house high performance batteries, the core component for both hybrids and electric cars.

Honda (7267. T, Neutral): Although No. 2, in hot pursuit of Toyota

Earnings impact

Honda's hybrid sales volume of roughly 60,000 units in FY3/08 accounted for less than 2% of consolidated sales, but we expect this to grow to 9% by 2010 (see Exhibit 6). Much will depend on the cost and price of its new pure hybrid, the Fit-based IMA Car (see Exhibit 7). Assuming mass production of about 400,000 units annually, we think hybrids could generate around 5% of Honda's consolidated operating profits by 2010.

Exhibit 6: Hybrids to account for over 9% of sales
Hybrids as a percentage of Honda's consolidated sales volume



Source: Company data, IRC, Goldman Sachs Research estimates.

Exhibit 7: Rapid expansion of product lineup in 2009
New hybrids planned by Honda (our estimates)

	Honda
2009	IMA car (Hybrid-only model)
2010	CR-Z (Sport type)
2010-	400 thou. annual unit sales of hybrid models 4 models (Civic hybrid, IMA, CR-Z, Fit hybrid)

Source: Company data, IRC, Goldman Sachs Research estimates.

Challenges

Challenges we see to Honda's hybrid strategy are the limitations inherent in mild hybrids and Honda's approach to battery development.

The IMA Car is based on the mild hybrid approach, which provides less fuel efficiency than a strong hybrid, but provides room for structural cost reductions in the motor and battery. Over the near term, we think mild hybrids may have a greater likelihood of being accepted by consumers, although the sticker price difference between the Civic hybrid and the Civic is about $5,000-6,000, roughly the same as the difference between a strong hybrid and regular model. However it is difficult to implement mild hybrid in large vehicles. In addition, taking into account the transition to electric cars, we think Honda will need at some point to expand its product lineup to include strong hybrids and plug-in hybrids.

As at Toyota, battery development is an issue. Honda's main supplier of batteries is Sanyo Electric. With both Toyota (Panasonic EV Energy) and Nissan (AESC) having controlling interests in battery subsidiaries, Honda appears to not have taken strategic action. Although it is difficult to tell from the outside how far along Honda is in developing batteries in-house, we will keep an eye on whether it is keeping up in lithium-ion batteries.

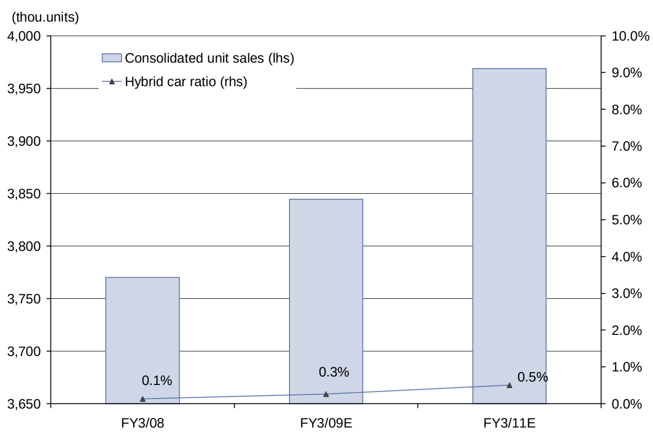
Nissan (7201.T, Neutral): Strategy to leapfrog to electric cars

Earnings impact

Nissan's hybrid sales volume of less than 10,000 units in FY3/08 accounted for only 0.1% of consolidated sales, and we expect this to grow to 0.5% by 2010. We do not envision a scenario in which Nissan generates significant profits from hybrid vehicles (see Exhibit 8).

Nissan has always viewed hybrids as nothing more than a stopgap on the way to electric cars, and its strategy clearly places more importance on electric car development, with limited development of hybrids. In 2010, Nissan plans to introduce a vehicle based on its own hybrid (its current hybrid model uses a unit from Toyota), but we do not see sales volume growing substantially higher than a few 10,000 units (see Exhibit 9). If the next ten years is the hybrid decade, Nissan may regret the lost opportunity.

Exhibit 8: Strategy for expanding hybrid sales is passive
Hybrids as a percentage of Nissan's consolidated sales volume



Source: Company data, IRC, Goldman Sachs Research estimates.

Exhibit 9: No widening of hybrid product lineup
New hybrids planned by Nissan (our estimates)

	Nissan
2009	N/A
2010	Own hybrid model (Lithium ion battery)
2010-	Expansion of models such as plug-in hybrid Full introduction of EV in Israel and Denmark

Source: Company data, IRC, Goldman Sachs Research estimates.

Challenges

As with rivals, battery development is a major issue. To develop batteries, Nissan established AESC, a joint venture with NEC and NEC-Tokin. AESC is focused on developing manganese lithium-ion batteries, and has announced a plan to increase annual production capacity to 13,000 units (vehicle basis) by 2009. This has the advantage of increased safety, since the use of spinel manganese as a cathode material strengthens the quartz structure, but AESC lags way behind Panasonic EV Energy in production scale. To address these cost differences, we think the challenge for Nissan will be to somehow advance a growth strategy that includes outside sales.

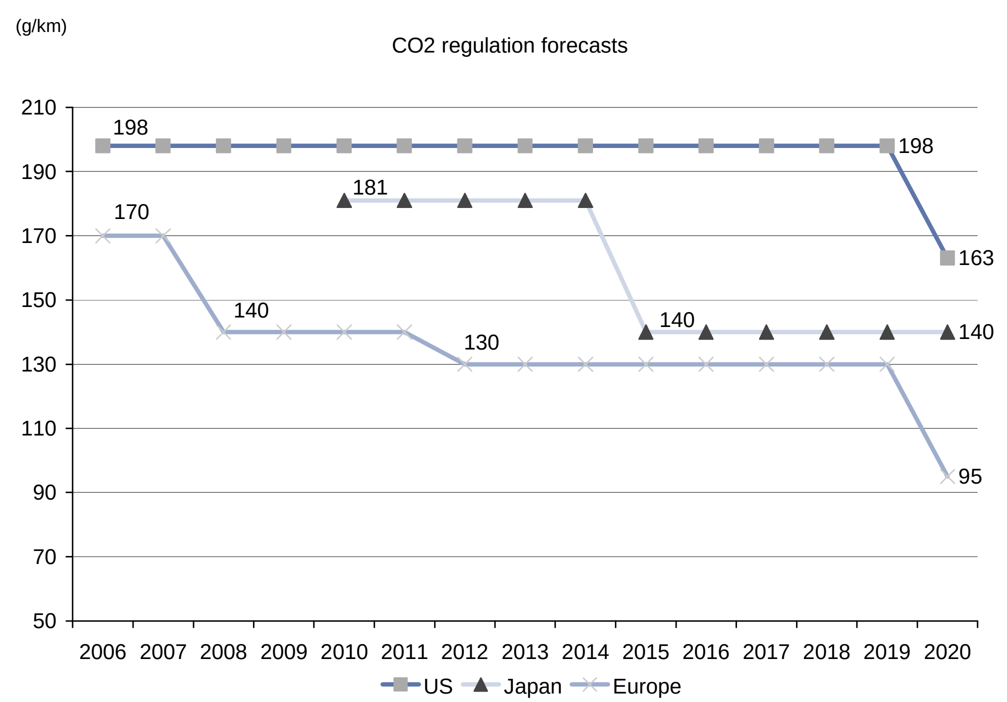
Market outlook: Hybrids will account for 10% of demand in 2020

As environmental standards grow stricter, hybrid technology is not the only power train technology being developed to reduce CO2 emissions. Electric cars are ideal for getting close to zero CO2 emissions, but a large variety of obstacles would need to be overcome in order to make the transition. We expect hybrid cars to play an important role through 2020 for three main reasons: (1) hybrid technology has been tested more extensively than other technologies, (2) hybrids do not have the same weaknesses as electric cars in terms of travel distance, and (3) hybrid technology is a bridge technology to electric cars. Accordingly, we expect the hybrid market to grow to 10% of total global automobile demand in 2020.

Environmental standards growing stricter

The trend toward stricter CO2 standards in industrialized economies continues. In Europe, which has the toughest regulations, CO2 emission standards (average emissions for each automaker) have been reduced to 130 g/km by 2012 compared to 170 g in 2006, and may be lowered to 95 g by 2020. Even in the United States, which lags behind Europe in CO2 regulations, federal corporate average fuel economy (CAFE) standards have been made stricter and a decision has been made to lower emission standards to 163 g by 2020. In addition, individual states such as California are moving to adopt stricter standards targeting earlier reductions (see Exhibit 10).

Exhibit 10: CO2 standards growing stricter in Japan, the United States, and Europe
Our forecasts of CO2 regulations by region



Note: Data from 2008 on are our forecasts.

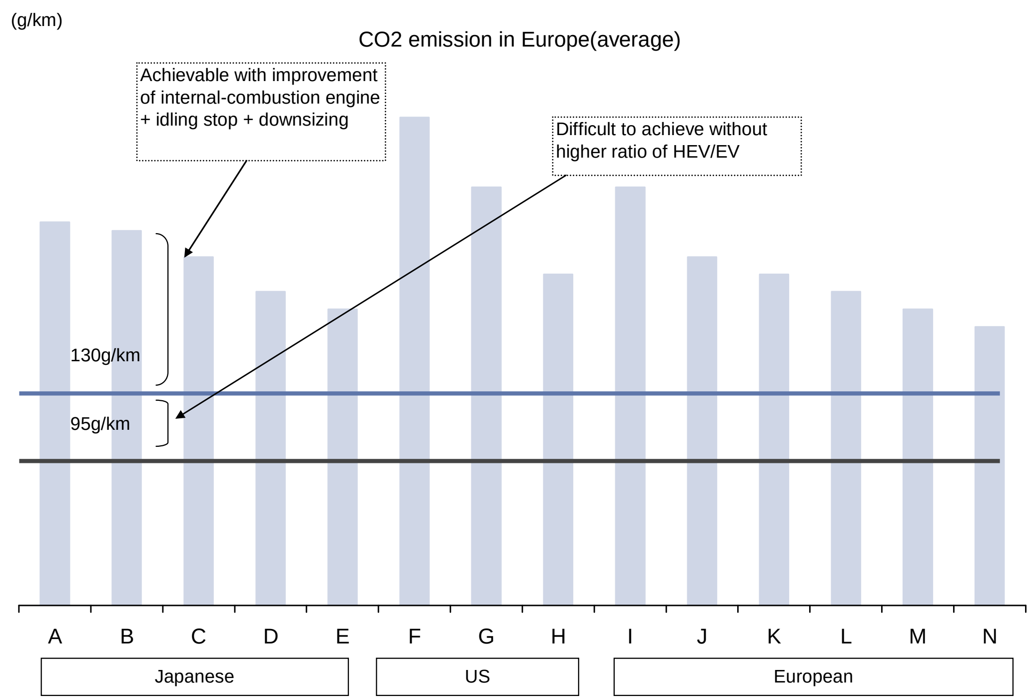
Source: Company data, Automotive Technology, Goldman Sachs Research estimates.

European 130 g/km may be limit for internal combustion engines

Automakers are stepping up efforts to meet the 2012 European CO2 emission standard of 130 g/km, but this is more than 35% below the 2006 average. Data comparing automakers' average CO2 emissions in Europe in 2006 are shown in Exhibit 11. The Big Three US automakers have comparatively high emissions, but even among the Japanese and European makers, no one meets the 130 g/km emission standard. All automakers need to overcome considerable obstacles to reach this target, and developing next-generation power trains is absolutely essential.

We note that these emission standards apply to each automaker's average fuel consumption. Given the difficulty of replacing existing product lineups completely, automakers must lower average fuel consumption by gradually increasing the percentage of vehicles with power trains that far exceed emission-reduction standards such as clean diesel, hybrid, and electric cars. In addition, they must look ahead to 2020 and the European emission standard of 95 g/km and US CAFE standard of 35 mpg.

Exhibit 11: No automaker had met European 130 g/km emission standard in 2006
Average CO2 emissions in Europe by manufacturer



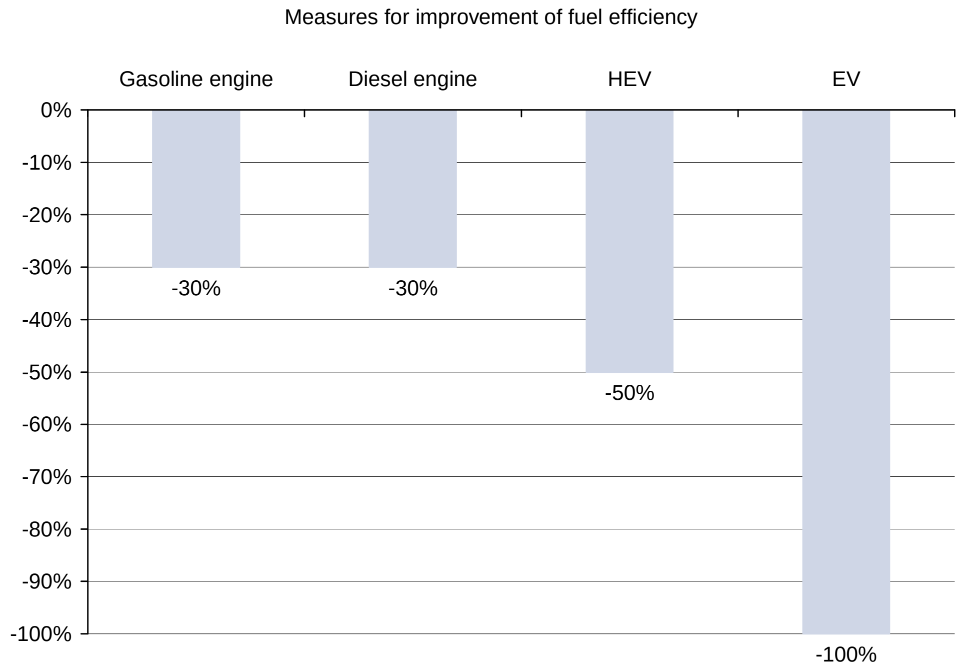
Note: We estimate CO2 regulation in EC will be 130 g/km until 2012, 95 g/km until 2020.

Source: Company data, Automotive Technology.

Next ten years the hybrid decade, then on to electric cars

Potential improvement in CO2 emissions achievable through various power trains is shown in Exhibit 12. The prevailing view is that there is room for about 30% improvement at most with gasoline and diesel engines. By contrast, CO2 emissions can be reduced 50% with hybrids and 100% with electric cars (see Exhibit 12). We expect a gradual long-term shift from gasoline and diesel engines to hybrids and electric cars. The only question is how long this will take. The clean diesel technology that European makers are devoting their energies to is a competitor in terms of improving fuel economy, but from the standpoint of the ultimate shift to electric cars, we think the maker that comes up with a next-generation battery-motor power train first is bound to have a considerable advantage.

Exhibit 12: We expect electric cars to become the prevailing technology long-term
Potential improvement in CO2 emissions with existing power trains



Note: Diesel includes clean diesel technology.

Source: Nissan data.

Hybrid technology tested more extensively than other technologies

Automobiles are consumer durables, with actual sales closely watched as autos are often used for 10 or more years and must meet a wide variety of safety standards. New power trains are subject to numerous road tests before they can go into production. Hybrid cars have established a vast sales record and much customer information and information about wear and tear has been collected. This makes it easier for makers to launch hybrids than cars with any other next-generation power train.

Aggregate sales of Toyota's Prius, for example, topped one million vehicles at end-April 2008, meaning a wide variety of road data and know-how has been accumulated (see Exhibit 13). Toyota launched the Prius, the world's first mass-produced hybrid car, in 1997, and began selling the Prius in North America, Europe, and other areas in 2000. It began making the Prius at a plant in Changchun, China, in 2005 and plans to begin selling it in South Korea in 2H2009. Toyota now sells the Prius in over 40 countries and regions worldwide. As a result, the Prius has become synonymous with hybrid.

Exhibit 13: Aggregate sales of Prius have topped the 1 mn mark
Prius sales by region

(thou. units)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008.4	Total
Total	0.3	17.7	15.2	19.0	29.5	28.1	43.1	125.8	175.2	185.6	281.3	107.1	1,027.9
Japan	0.3	17.7	15.2	12.5	11.0	6.7	17.0	59.8	43.7	48.6	58.3	24.2	315.0
Overseas	0.0	0.0	0.0	6.5	18.5	21.4	26.1	66.0	131.5	137.0	223.0	82.9	712.9
North America	0.0	0.0	0.0	5.8	16.0	20.3	24.9	55.9	109.9	109.0	183.8	66.1	591.7
Europe	0.0	0.0	0.0	0.7	2.3	0.8	0.9	8.1	18.8	22.8	32.2	14.2	100.8
Others	0.0	0.0	0.0	0.0	0.2	0.3	0.3	2.0	2.8	5.2	7.0	2.6	20.4

(regional share)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008.4	Total
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Japan	100%	100%	100%	66%	37%	24%	39%	48%	25%	26%	21%	23%	31%
Overseas	0%	0%	0%	34%	63%	76%	61%	52%	75%	74%	79%	77%	69%
North America	0%	0%	0%	31%	54%	72%	58%	44%	63%	59%	65%	62%	58%
Europe	0%	0%	0%	4%	8%	3%	2%	6%	11%	12%	11%	13%	10%
Others	0%	0%	0%	0%	1%	1%	1%	2%	2%	3%	2%	2%	2%

Source: Company data.

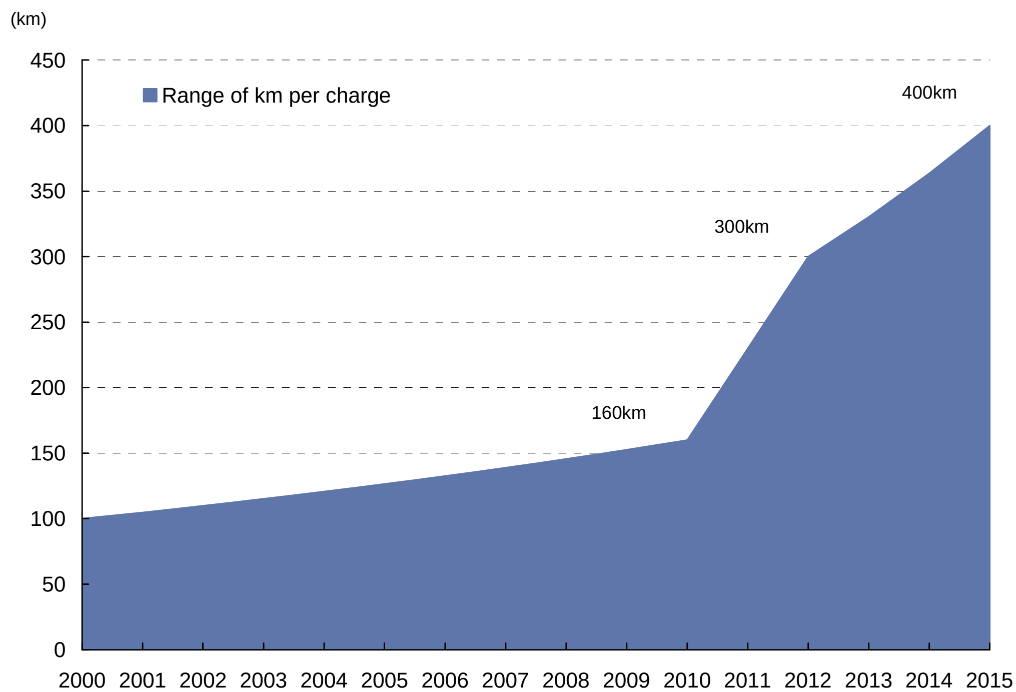
Not subject to range limitations of electric vehicles

Market uptake of electric vehicles depends on improvement in the range they can travel on one charge and the construction of public infrastructure such as battery stations. We thus see the combination of an internal combustion engine and electric motor as the optimal solution at the moment in terms of range and fuel economy. Nissan's aim is to extend the range of the zero-emission car concept it announced in May 2008 to 160 km in 2010 and 300 km in 2012 (see Exhibit 14). Without a quantum leap in battery technologies, we do not expect electric vehicles to become mainstream for at least the next 5-10 years. As battery technologies improve, the market for plug-in hybrids is likely to grow significantly.

Development of motors, batteries a bridge to electric vehicles

We expect sales of hybrid vehicles to exceed 1.0 mn in 2010. Cost reductions from mass production should therefore be significantly greater than for electric vehicles, output of which is unlikely to exceed several thousand. Toyota, for example, plans to halve costs for the next-generation Prius to be launched in 2009. The fact that volume production of batteries and power control units could be leveraged in electric vehicles is a considerable incentive for auto assemblers to develop hybrids.

Exhibit 14: Electric vehicle range of no more than 160 km in 2010 even for Nissan
Nissan electric vehicle range per charge targets for GT2012



Source: Company materials.

Second growth phase for hybrid vehicles in 2009

Several new hybrid vehicles will be launched in 2009, and with interest in the environment increasing, we expect demand to grow. As noted previously, the two companies most advanced in hybrid vehicle development globally are to launch high-volume models. In 2010, we expect Toyota to launch a plug-in hybrid, Honda to release the CR-Z, and Nissan to introduce its own hybrid vehicle. In addition, non-Japanese auto assemblers plan to flesh out their product lineup in hybrid vehicles. In addition, US and European manufacturers, which have been less aggressive on hybrids, have started showing signs of interest in the market over the last six months. We expect that hybrid vehicles, which will play a transitional role in the shift from traditional power trains to electric cars, will become the key environmental player over the next ten years (see Exhibit 15).

Exhibit 15: Renewed growth in hybrid vehicles in 2009
Auto assemblers' hybrid vehicle lineups

Manufacturer	Vehicle	2008	2009	2010	2010 onwards
Toyota	Prius Camry hybrid Highlander hybrid Estima hybrid Alphard hybrid Crown hybrid Harrier/RX (Lexus) hybrid GS (Lexus) hybrid LS (Lexus) hybrid	--	Prius (third generation) SAI (dedicated hybrid) FT - HS (V6, 3.5 l engine)	Corolla hybrid Vitz hybrid Plug-in hybrid (lithium ion)	Launch of 1/X hybrid (44 km per liter) Hybrid sales of 1.0 mn vehicles annually
Nissan	Altman hybrid	--	--	Own hybrid (lithium ion)	Upgrading vehicle lineup with plug-in hybrid and like
Honda	Civic hybrid Accord hybrid (suspended design in 2007 FMC)		IMA Car (dedicated hybrid)	CR-Z (sports car)	Targeting hybrid sales of 400,000. Three-model lineup: Civic, IMA, CR-Z
Mitsubishi	--	--	--	--	No specific schedule
Mazda	--	Start of lease sales for Premacy hydrogen hybrid	--	--	No specific schedule
Suzuki	--	--	Hybrid SUV (3000 cc) developed jointly with GM	--	No specific schedule
Fuji Heavy	--	--	--	--	Commercialization of hybrid in 2010 or later (joint development with Toyota)
GM	Aura hybrid (Saturn) Malibu hybrid (Chevrolet) Tahoe hybrid (Chevrolet)	--	Silverado hybrid (dual mode)	--	Plans release of plug-in hybrid
Ford	Escape hybrid (Ford) Mariner hybrid (Mercury)	Plans launch of 8 new hybrid vehicles, including Fusion, 500, Edge, Milan, Montego and Lincoln MKX			No specific schedule
Daimler	--	--	--	--	To commercialize system jointly developed with GM, BMW for luxury cars by 2010
Chrysler	Aspen HEMI hybrid (Chrysler) Dragon HEMI hybrid (Dodge)	--	--	--	No specific schedule
VW/Audi	--	--	Audi A1 hybrid (jointly developed with Porsche)	--	No specific schedule
BMW	--	--	--	--	To commercialize system jointly developed with GM, Daimler for luxury cars by 2010
Renault	--	--	--	--	No specific schedule

Source: Company materials, IRC, Goldman Sachs Research estimates.

Halving of third-generation Prius costs to stimulate demand

We also expect considerable progress in reducing the cost of hybrid units in 2009, when Toyota is to announce the third-generation Prius. The company says it aims to reduce the cost of the hybrid unit in the new vehicle from ¥400,000 to ¥200,000.

We estimate that the battery, motor, and electronic control unit each account for one third of the cost of the hybrid unit. We believe costs could be halved through improvements in the battery and electronic control unit. We expect Toyota to continue to use a nickel-hydride battery in the third-generation Prius, and think the company will aim to cut costs through the optimization of the state of charge and reduction in cell size and weight. In addition to mass production of the electronic control unit, simplification of circuitry and systems should contribute to cost reductions.

If Toyota passes on these cost reductions in sales price cuts, the period over which a consumer recovers their investment in a hybrid vehicle, ie, the number of years it takes for reduced gasoline spending to compensate for the hybrid vehicle price premium, should be shortened. As fuel consumption should improve further in the new Prius, the number of years required to recover the investment premium could fall by more than half (see Exhibit

16). Accordingly, we expect cost reductions to improve profitability of hybrid vehicles for manufacturers and enable them to aggressively expand sales.

Exhibit 16: Hybrids to become more economical given high gasoline prices, cost cuts
Simulation of annual gasoline costs and hybrid cost recovery in US (units: years)

Payback period（4 cylinder）

Payback period	Price difference of $4,000	Price difference of $2,000	Price difference of $1,000
$4.0/gallon	5.8	2.9	1.4
$3.5/gallon	6.6	3.3	1.7
$3.0/gallon	7.7	3.9	1.9
$2.5/gallon	9.2	4.6	2.3
$2.0/gallon	11.6	5.8	2.9

Payback period（V6）

Payback period	Price difference of $4,000	Price difference of $2,000	Price difference of $1,000
$4.0/gallon	4.5	2.2	1.1
$3.5/gallon	5.1	2.6	1.3
$3.0/gallon	6.0	3.0	1.5
$2.5/gallon	7.2	3.6	1.8
$2.0/gallon	9.0	4.5	2.2

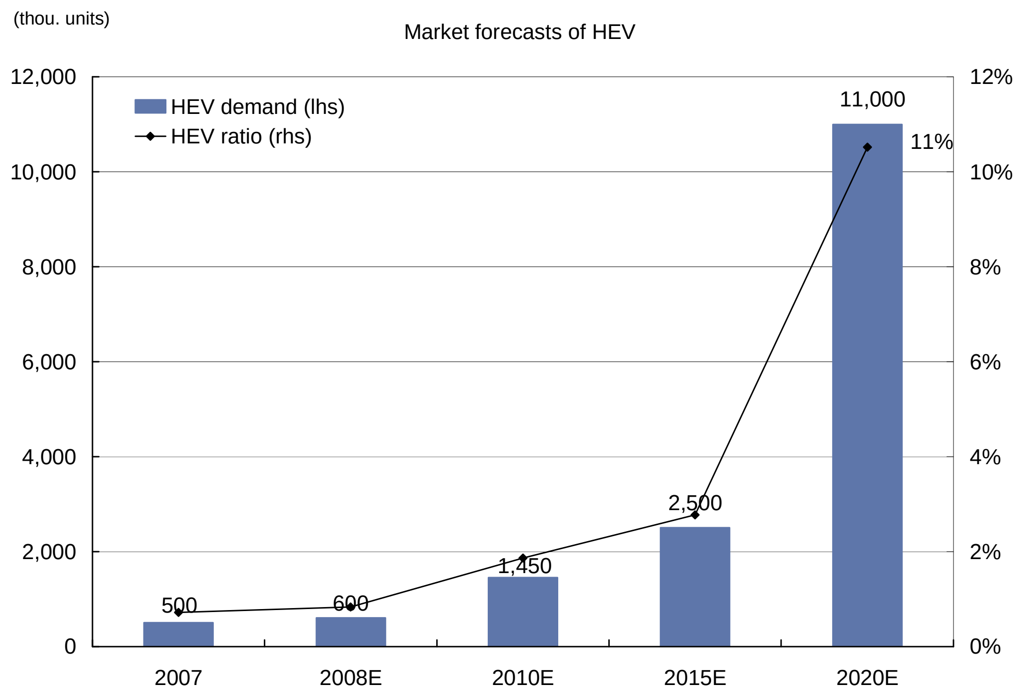
Note: We assume annual mileage of 10,000 miles at standard mpg.

Source: Company data, Goldman Sachs Research calculations.

Some expect hybrid market to top 10.0 mn vehicles in 2020

In FY3/07, the 600,000 hybrid vehicles sold worldwide accounted for less than 1% of the total market. We expect the hybrid market to grow to 1.45 mn vehicles in 2010, and 2.5 mn in 2015. Some manufacturers of hybrid vehicles plan capital spending and R&D budgets in line with a market of over 10.0 mn vehicles in 2020. We think hybrid vehicles could account for more than 10% of global auto sales (see Exhibit 17).

Exhibit 17: Hybrid vehicle market to grow towards 2020
Hybrid vehicle market forecasts



Source: Company materials, Goldman Sachs Research estimates.

Technologies: Batteries the key to market penetration. Winner not yet decided

Battery technology development is the key to growth in hybrid and electric vehicles. In 2009-2010, we expect a shift to lithium-ion battery technologies from the current nickel-hydride. This should help decrease in battery size and increase capacity as well as cost reductions. Development of lithium-ion batteries, however, is by no means complete. At this point, Panasonic EV Energy, owned 60% by Toyota and 40% by Matsushita, is the industry leader, but relative positionings are by no means fixed.

Lithium-ion battery performance key to market uptake of hybrids

Battery development is, naturally, critical to growth not only in hybrid vehicles, but also electric cars. Hybrid vehicles currently use nickel-hydride batteries, but we expect lithium-ion to become mainstream in 2009-2010. Key issues for battery development are performance and cost. In a policy directive released in August 2006, the Ministry for Economy, Trade and Industry targeted 1.5X improvement in performance by 2015, and a reduction in costs to 1/7 (see Exhibit 18).

Exhibit 18: High efficiency, low-cost the key issues for battery development
METI battery development roadmap

	Current battery	Improved battery	Advanced battery	Innovative battery
Timing	Aug/2006	2010	2015	2030
Application	Small EV for power companies	Commuter EV (limited application) High performance HEV	General commuter Fuel cell vehicle Plug-in HEV	Full scale EV
Performance	1X	1X	1.5X	7X
Cost	1 (¥200 thou/kWh)	1/2 (¥100 thou/kWh)	1/7 (¥30 thou/kWh)	1/40 (¥5 thou/kWh)

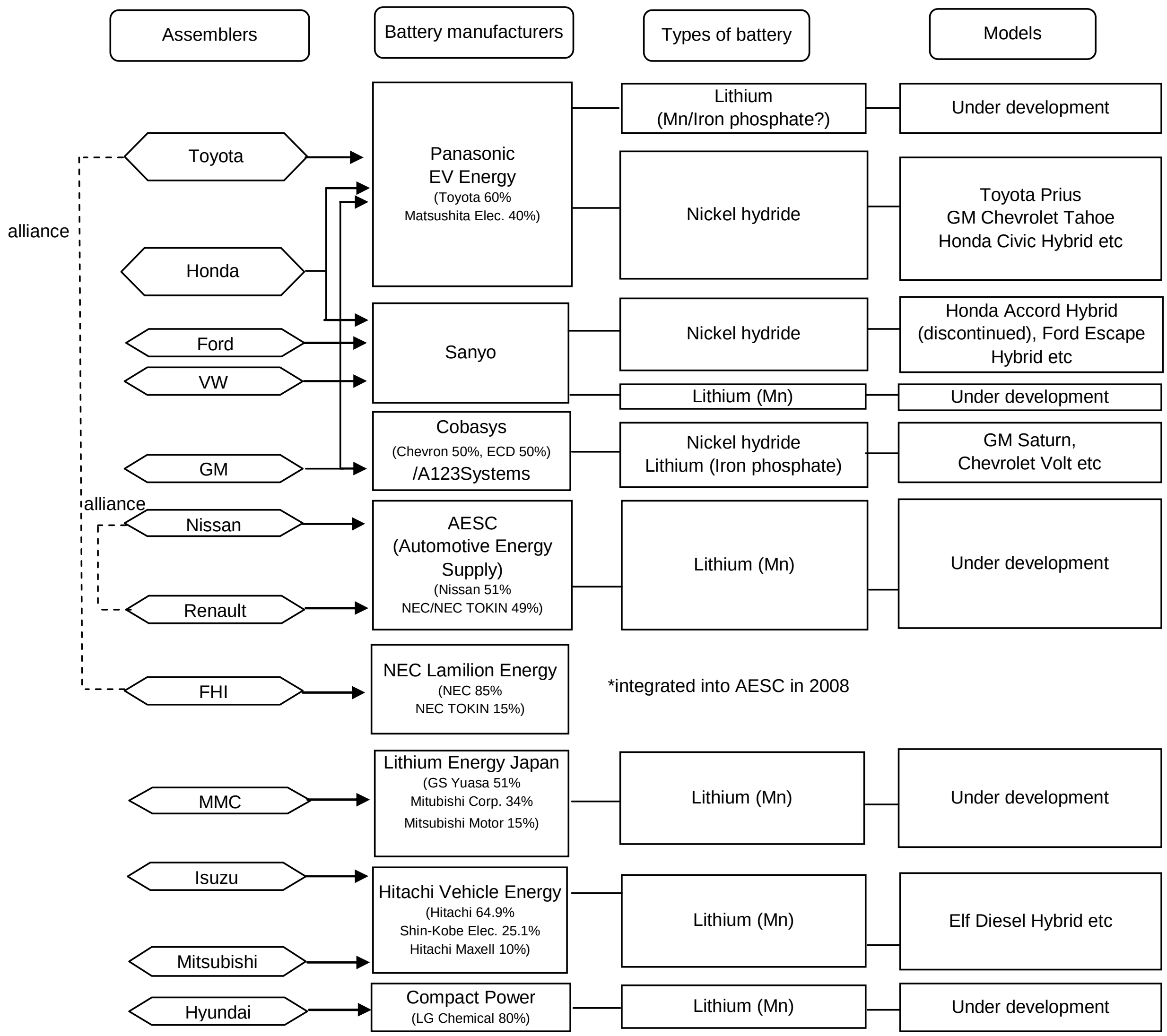
Source:METI.

More than 10 companies worldwide devoted to development

Batteries are one of the most important fundamental components for hybrid and electric vehicles. Not only are range per charge, power output, and safety important issues, but factors such as climate, temperature, and road surface come into play. We expect a shift to lithium-ion technologies for mainstream batteries. There have been a number of joint ventures and capital tie-ups in this area over the past few years. Unlike nickel-hydride technologies, however, the development of lithium-ion batteries is by no means complete. The relative positioning of hybrid vehicle manufacturers could change dramatically depending upon which battery manufacturer begins volume production, at what time, and using which electrode material.

In Japan, the main players developing lithium-ion batteries are Panasonic EV Energy (Toyota 60%, Matsushita 40%), Sanyo Electric, AESC (Automotive Energy Supplier, Nissan 51%, NEC group 49%), GS Yuasa, and Hitachi Vehicle Energy (Hitachi 64.9%, Shin-Kobe Elec. 25.1%, Hitachi Maxell 10%). Overseas players include Johnson Control-Saft (JCI 100%) in Europe, Cobasys (Chevron 50%, Energy Conversion Devices 50%) in the US, and Compact Power (LG Chemical 80%) in Korea. Overall, more than 10 companies are developing lithium-ion batteries (see Exhibit 19).

Exhibit 19: Global manufacturers stepping up battery development efforts
Battery procurement by auto manufacturer



Source: Company data, Sanyo Electric, Automotive Technology.

Lithium-ion batteries still a developing technology

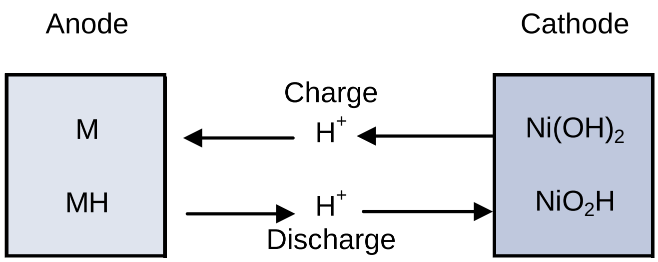
Lithium-ion batteries hold an advantage over nickel-hydride for power density (high) and size/weight (low). Per-cell voltage is generally 3.6V for lithium-ion versus 1.2V for nickel-hydride, which cannot go any higher due to the use of alkali electrolyzing solutions.

However, heat control is a problem with lithium-ion batteries and safety issues have been an obstacle to automotive use. Toyota reportedly intended to use a lithium-ion battery for the third-generation Prius but ultimately decided on nickel-hydride for safety reasons.

Two makers have revealed mass production plans for lithium-ion batteries— Panasonic EV Energy (Toyota camp) and AESC (Nissan). On May 19, 2008 Nissan announced that production was in sight using a manganese spinel (patented by NEC) with a stable crystal structure for the cathode (positive electrode). Panasonic EV Energy, Sanyo Electric, and Hitachi Vehicle Energy are also likely to use a manganese cathode, but might use iron phosphate for even greater safety. As yet, there is no single defining material for lithium-ion batteries.

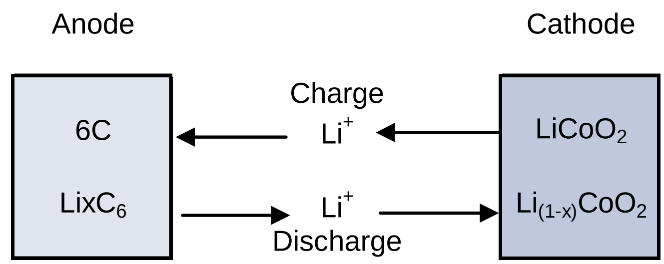
Exhibits 20 and 21 show the structure of nickel-hydride and lithium-ion batteries.

Exhibit 20: Nickel-hydride batteries close to perfection
Nickel-hydride battery structure



Source: Automotive Energy Supply Corporation.

Exhibit 21: Lithium-ion batteries still developing
Lithium-ion battery structure



Source: Automotive Energy Supply Corporation.

Hybrid basics: Format determines cost/performance and competitiveness

The term hybrid covers a variety of formats and large differences in fuel consumption improvement and cost structure. The strong hybrid format used by Toyota carries high structural cost but represents a necessary stage in development for fuel consumption and electric vehicles. The mild hybrid format adopted by Honda has the potential to be cost-competitive if mass production benefits are realized, but it is difficult to apply it to large vehicles. We expect to see format diversity in the transition to electric vehicles, but expect the gasoline engine-based strong hybrid will be mainstream.

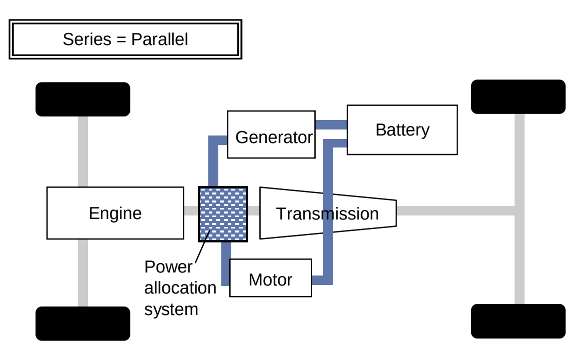
Cost and performance differences between strong and mild

Hybrid vehicles are categorized as either strong (full) hybrid or mild.

Strong hybrid: Strong hybrid vehicles are more motor-oriented than mild. They have two power sources, one to generate electricity and one to drive the vehicle, and can run on the motor alone. As shown in Exhibit 22, the systems are large and costs tend to be high, but we see strong hybrid as an important step toward electric vehicles in terms of motor and battery development. The Toyota Hybrid System (THS) is a typical example. We put current strong hybrid unit costs at US$4,000-US$6,000.

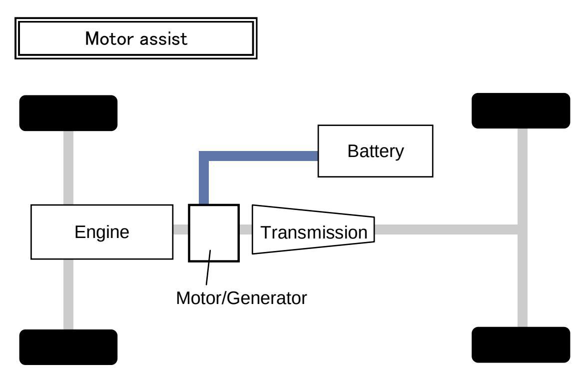
Mild hybrid: Honda is the prime user of this technology, which it calls Integrated Motor Assist (IMA). There is only one motor, which plays a support role for an internal combustion (gasoline) engine. Systems are simpler than for strong hybrid and there are also cost advantages (see Exhibit 23). However, the transition to electric vehicles and application to large vehicles will be difficult and the improvement in fuel consumption is smaller than for strong hybrid.

Exhibit 22: Strong hybrid has two motors
Series-parallel



Source: Motor Fan.

Exhibit 23: Mild hybrid has one motor
Motor-assisted



Source: Motor Fan.

Watch whether Toyota moves into mild hybrid

Honda's view appears to be that hybrid is best for small cars but diesel is the best power train for large models. It has discontinued hybrid versions of the Accord effective from 2008 models. Most makers have pursued hybrid development since Toyota's Prius debuted, but mild hybrid has been the mainstream. The light weight of Honda's IMA has been deployed to particular effect in small cars. Toyota development so far has been with an eye to electric vehicles with a focus on strong hybrid. We expect future hybrid market growth to be strongly influenced by Toyota's format choice for cars in the Yaris class.

Diesel hybrid unlikely to catch on

The objective of hybrid technology is to obtain optimum fuel consumption and power from a combination of power trains. Gasoline hybrid is the mainstream, but other possibilities include diesel and plug-in. We doubt diesel hybrid will gain currency. Diesel engines are generally higher cost than gasoline due to nitrogen oxide (NOx) and particulate matter (PM) scrubbing costs, and we do not expect consumers to be receptive to the overall extra cost of a diesel hybrid system. In addition, torque strength is the attraction for drivers in the case of both diesel and hybrid, and we do not think makers can achieve the desired performance by combining the two.

Plug-in hybrid a further step toward electric vehicles

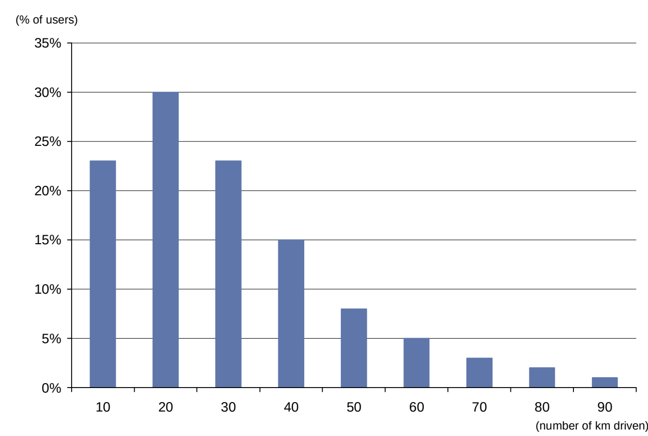
Toyota is said to be developing plug-in hybrid with a view to commercialization around 2010. We envisage a Prius using a lithium-ion battery. The objective of plug-in hybrid is to increase the distance a vehicle can run on electricity, making gasoline consumption unnecessary for a certain degree of vehicle usage. The technology seems a logical link between hybrid and electric vehicles, given that battery energy density is in the process of improvement and full-scale electric vehicle operation will require dedicated charging infrastructure (see Exhibit 24). A key issue for plug-in hybrid is the distance set by the manufacturer for running on electricity alone.

Exhibit 24: Plug-in hybrid technology is a further step toward EV
Performance comparisons

	EV	PHV (EV base)	PHV (HEV base)	HV
CO2	◎	○～◎	○～◎	○
Air pollution	◎	○～◎	○～◎	○
Range of miles	×	○	◎	◎
Charging time	×	△	○	◎
Infrastructure for charging	× (necessary)	× (necessary)	○	◎
Cost	×	△～×	○	◎

Source: Motor Fan.

Exhibit 25: Most cars are driven less than 20km/day on average
Distances driven by car users



Source: Motor Fan (Mar. 2008), Toyota.

Reg AC

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