

Electric Vehicles

Research Analysts

Patrick Jobin
212 325 0843
patrick.jobin@credit-suisse.com

Jun Yamaguchi
813 4550 9789
jun.yamaguchi@credit-suisse.com

Gary Balter
212 538 4228
gary.balter@credit-suisse.com

Christopher J. Ceraso, CFA
212 538 4529
chris.ceraso@credit-suisse.com

Adrian Chan
852 2101 6469
adrian.c.chan@credit-suisse.com

Dan Eggers, CFA
212.538.8430
dan.eggers@credit-suisse.com

Arndt Ellinghorst
44 20 7888 0295
arndt.ellinghorst@credit-suisse.com

Mark Flannery
212 325 7446
mark.flannery@credit-suisse.com

John P. McNulty, CFA
212 325 4385
john.mculty@credit-suisse.com

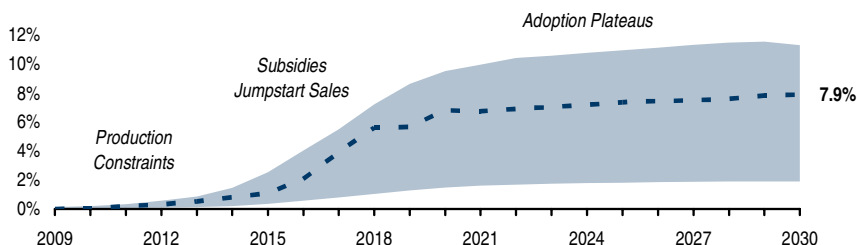
Stuart Pearson
44 20 7888 0765
stuart.pearson@credit-suisse.com

John W. Pitzer
212 538 4610
john.pitzer@credit-suisse.com

THEME

Back to the Future

Exhibit 1: Global Electric Vehicle Penetration Rate



Source: Credit Suisse estimates

- **Electric Vehicles offer one of the fastest growth stories over the next twenty years.** We expect automotive sales of electric vehicles to rise to over \$400 billion by 2030 with batteries rising to over \$100 billion and incremental charging infrastructure spending of at least \$170 billion through 2030. We believe that 1.1% of global vehicle sales will be electric by 2015, driven by more than \$15 billion in subsidies. That number could climb to nearly 7.9% by 2030. Hybrid electric vehicles could reach 5.9% by 2030 from 0.6% today. Nearly every auto manufacturer has plans to develop electric vehicles, with many models targeted to launch in 2010.
- **Lithium ion battery market projected to grow to over \$100 billion.** Given the massive growth opportunity and high cost of Lithium Ion batteries, we expect the market size for large-scale lithium ion batteries to grow substantially, potentially reaching \$100 billion within 20 years. Volumes will grow faster than the market size as prices decline with costs.
- **We envision material impacts on oil and electricity demand by 2030** as oil consumption falls by 4 million barrels per day and electricity demand increases by 3.1%. Electric vehicles, beyond reducing greenhouse gas emissions, provide valuable grid storage and enable more wind and solar power generation, facilitating a disruptive shift in global energy flows.
- **Battery material companies and component manufacturers are the best way to invest, due to top-line growth and sustainable margins.** Our top long-term stock picks for materials and components are Kureha, Nidec, Rohm, Furukawa Electric, Mitsubishi Chemical, Ube Industries, and ON Semiconductor. While we have a bearish view on battery makers due to potential commoditization, those that can protect their IP and defend margins should benefit. Within this category we highlight BYD, Johnson Controls, Panasonic, and Sanyo Electric.

In conjunction with this report, Japan published a report on the supply chain and the US Specialty Chemicals team published a report on lithium.

DISCLOSURE APPENDIX CONTAINS IMPORTANT DISCLOSURES, ANALYST CERTIFICATIONS, INFORMATION ON TRADE ALERTS, ANALYST MODEL PORTFOLIOS AND THE STATUS OF NON-U.S. ANALYSTS. FOR OTHER IMPORTANT DISCLOSURES, visit www.credit-suisse.com/researchdisclosures or call +1 (877) 291-2683. U.S. Disclosure: Credit Suisse does and seeks to do business with companies covered in its research reports. As a result, investors should be aware that the Firm may have a conflict of interest that could affect the objectivity of this report. Investors should consider this report as only a single factor in making their investment decision.

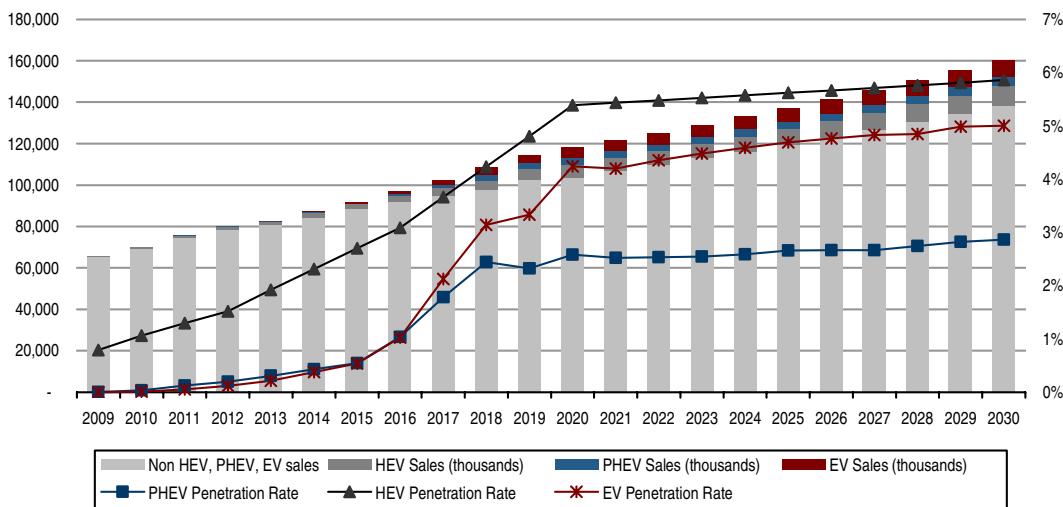
Executive Summary

In conjunction with this report, the Japan Technology and Materials team, along with the US Specialty Chemicals team, have published sector-specific reports on electric vehicles. This report provides a summary of key conclusions and presents a potential adoption rate for electric vehicles. We have also developed an interactive model that allows clients to modify assumptions. Please contact your Credit Suisse representative to obtain a copy.

Electric Vehicles offer one of the fastest growth stories over the next twenty years.

We expect automotive sales of electric vehicles to rise to over \$400 billion by 2030 with batteries rising to over \$100 billion and incremental charging infrastructure spending of at least \$170 billion. We believe that 1.1% of global vehicle sales will be electric by 2015, driven by more than \$15 billion in subsidies. That number could climb to 7.9% by 2030, hybrid electric vehicles could reach 5.9% by 2030 from 0.6% today. Nearly every auto manufacturer has plans to develop electric vehicles, with many models launching in 2010.

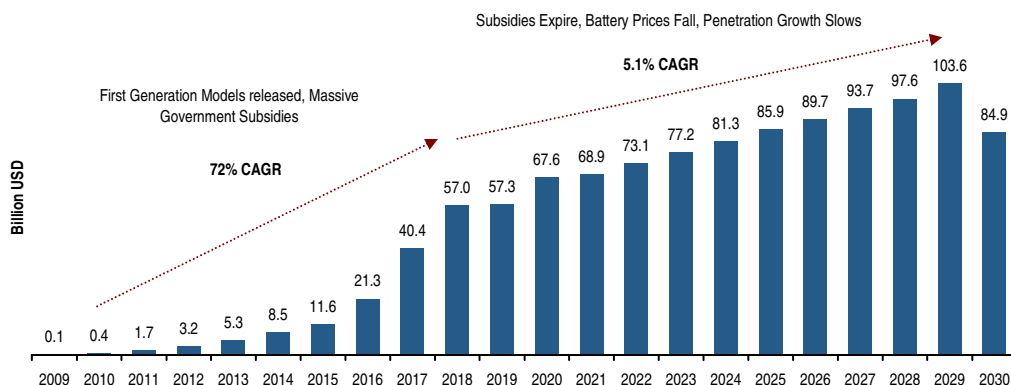
Exhibit 2: Summary of Forecast: HEVs, PHEVs, and EVs still represent a small portion of vehicle sales



Source: Credit Suisse estimates

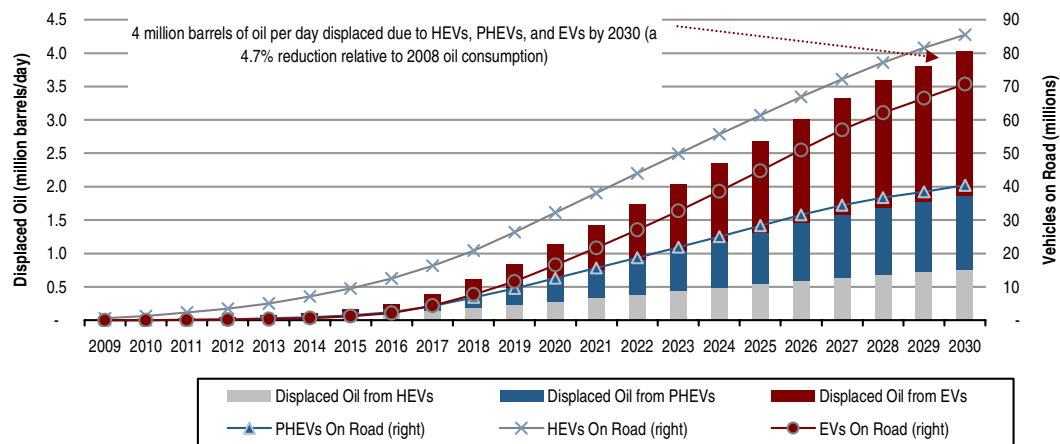
Automotive lithium ion battery market projected to grow to over \$100 billion. Given the massive growth opportunity and high cost of Lithium Ion batteries, we expect the market size for large-scale lithium ion batteries to grow substantially, potentially reaching \$100 billion within 20 years. Volumes will grow faster than the market as prices decline.

Exhibit 3: Large Format Lithium Ion Battery Market Size: Potentially Reaching \$100+ billion within 20 years



We envision material impacts on oil and electricity demand by 2030 as oil consumption falls by 4 million barrels per day and electricity generation increases by 3.1%. Electric vehicles, beyond reducing greenhouse gas emissions, provide valuable grid storage and enable more wind and solar power generation, facilitating a disruptive shift in global energy flows.

Exhibit 4: Oil Consumption Decreases by 4 million barrels per day

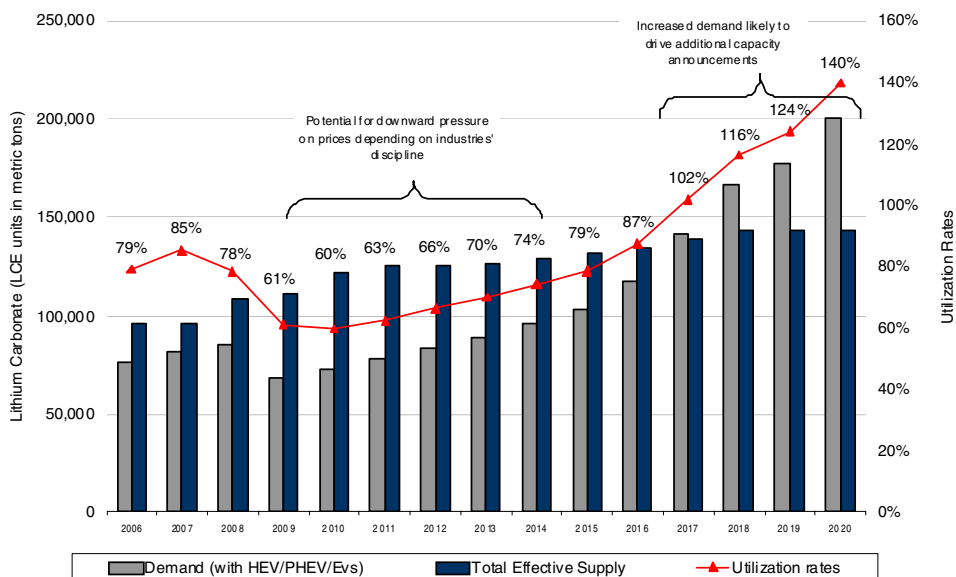


Source: Credit Suisse estimates

We also project significant spending on incremental charging stations, the smart grid and smart meters, which will play a role in the growth of the electric vehicles. Through 2030, we estimate a need for \$170 billion in charging infrastructure investment, something the public sector, along with consumers, will be expected to pay for indirectly.

From a raw material perspective, we expect robust lithium volume growth of 10.8% from 2009-2020, largely driven by electric vehicles. This growth will be driven by mid-single digit demand from the traditional end-markets with incremental growth picking up in the out years tied to demand stemming from batteries in hybrid electric vehicles and electric vehicles. Despite robust demand, we expect pricing to remain flat with the risk likely to be to the downside.

Exhibit 5: Lithium Supply Demand Balance Including Demand from Electric Vehicles

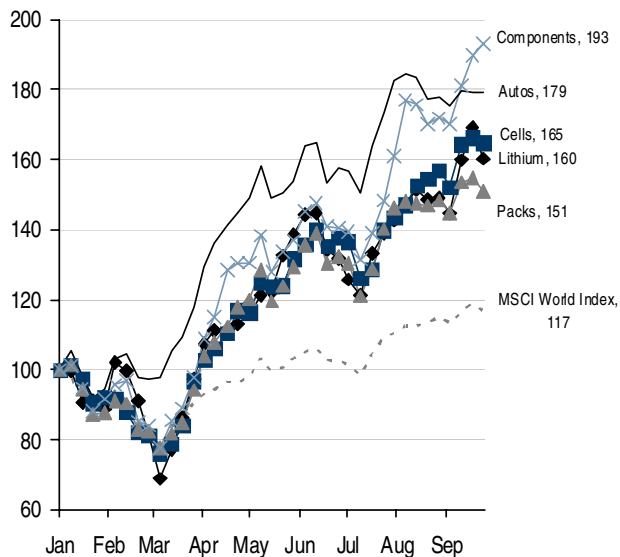


Source: Company data, Credit Suisse estimates, US Specialty Chemicals Team

Investment Thesis

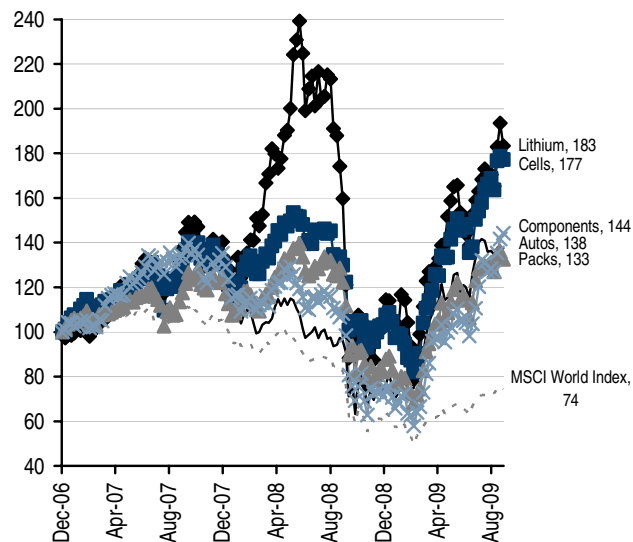
Stocks exposed to electric vehicles have significantly outperformed during the last three years, testament to the attention this sector is getting. Year to date, battery cell producers are up 65%, lithium producers have increased 60%, battery pack companies jumped 51%, and component companies have risen 93%.

Exhibit 6: YTD Stock Performance



Source: Company data, Credit Suisse estimates, as of 9/25/2009

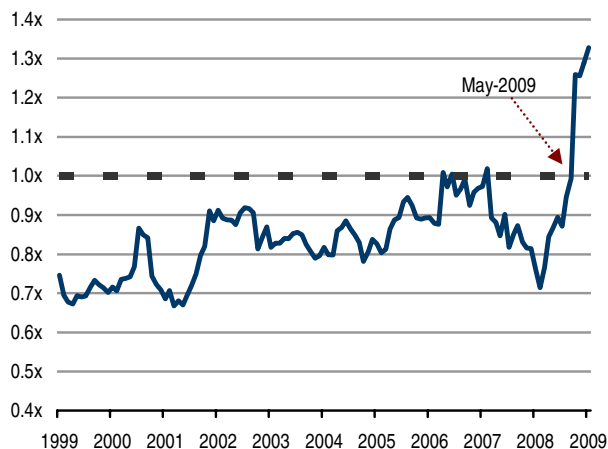
Exhibit 7: Stock Performance from 2007



Source: Company data, Credit Suisse estimates, as of 9/25/2009

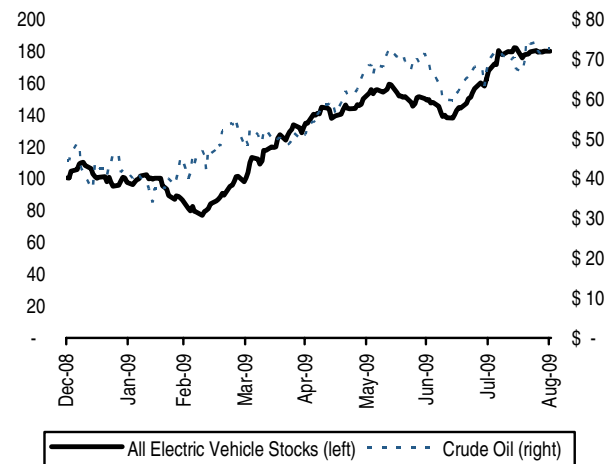
The sector has traditionally traded at a discount to the market, but that has reversed in early 2009, with the sector now trading at a 30% premium. We believe this valuation, which is indicative of stocks potentially running ahead of themselves, is also testament to the fact that electric vehicles are becoming more of a reality. **We believe that the adoption of electric vehicles will occur, and while valuations may be rich on current earnings, investors can start selecting names that will likely see material top-line growth in 5+ years within industries that will be able to defend margins.**

Exhibit 8: Sector now trades at a premium relative to S&P 500 (EV/TTM EBITDA)



Source: Company data, Credit Suisse estimates

Exhibit 9: Stocks are highly correlated to oil, but correlation may decline as electric vehicles materialize



Source: Company data, Credit Suisse estimates

We believe electric vehicles will dramatically impact many industries, and therefore focus on industries likely to experience defensive margins long-term. We believe the best areas to invest in are the chemical materials and component companies due to top-line growth and defensive margins, along with the battery companies that are able to retain their intellectual property and pricing power.

Lithium-ion battery manufacturers: While we believe these firms will enjoy strong sales growth, the market will likely become very competitive. Batteries face a strong risk of becoming commoditized. Many Japanese battery makers have formed tie-ups or joint ventures with automakers, making it difficult for battery makers to retain value-added in house and increase profits. Those that retain all IP are likely to be better positioned to retain margins, such as BYD and JCI. While we do not have coverage of A123 (AONE US, not rated) and Ener1 (HEV US, not rated), we note that they do offer direct exposure to lithium ion batteries for electric vehicles.

- BYD (1211 HK, Outperform): Not only is BYD an up and coming auto maker, they have battery expertise and the ability to retain intellectual property. Recently the underdog in the auto market, they now have 4% of market share (by volume). While not a significant portion of revenue, BYD has launched its all-electric vehicle, which could be well received in the Chinese marketplace.
- Johnson Controls (JCI, Outperform): The company has the largest market share of lead acid batteries and is also developing a lithium ion battery in a partnership with Saft. JCI should benefit from increased production of electric vehicles. We also highlight that Saft (S1A.PA, Not covered), a French battery company, also offers direct exposure.
- Panasonic (6752 JP, Neutral): Panasonic is exposed to the automotive battery market (both NiMH and Li-ion) through Panasonic EV Energy (PEVE), a 60-40 JV between Toyota and Panasonic. In the area of automotive Li-ion, we expect PEVE to mainly supply its parent, Toyota Motor. In terms of profits, we believe margins on Li-ion batteries will be similar to those on NiMH batteries in the early stages – when high levels of capex and R&D expenses pushed down earnings. Panasonic plans a TOB of Sanyo Electric, the global leader in small Li-ion batteries for use in notebook PCs, mobile phones etc. When combined with Sanyo, we expect Panasonic's market share in automotive Li-ion batteries to exceed 20% in 2020.
- Sanyo Electric (6764 JP, Neutral): Sanyo Electric is the number one global producer of small Li-ion batteries for use in notebook PCs, mobile phones etc. The company is now at the stage where we expect it to increase investment in HEV batteries in response to the increase in demand. The main differences with the company's competitors are: (1) the company is maintaining its competitiveness while generating steady cash flows in the consumer Li-ion batteries business, (2) the HEV NiMH battery business has finally started to generate profits and (3) the company aims to commence production of automotive Li-ion batteries within the year. The battery business as a whole should be able to generate sustainable positive cash flows. We expect sales of automotive Li-ion batteries to expand to ¥215.8bn by 2020.

Lithium-ion battery materials: The likely winners among material makers are those firms that can fulfil criteria such as: (1) technological lead (creates high entry barrier; stocks: Ube Industries, Kureha), (2) a dominant market share (Furukawa Electric) and (3) provide one-stop supply of a wide range of materials (Mitsubishi Chemical HD). The main materials (anodes, cathodes, electrolytes and separators) are estimated to grow at an average annual rate of 13% from 2009 through 2020.

- Kureha (4023 JP, Outperform): Kureha produces hard carbon anodes that have demonstrated a unique feature of random carbon crystal convergence. Over the medium term, its hard carbon anodes should contribute to earnings through use in batteries for hybrid vehicles.

- Ube Industries (4208 JP, Outperform): Ube Industries produces electrolytes and separators for lithium ion batteries. The company has steadily expanded production over six years, and we understand its newest facilities are already operating at full utilization. We expect Ube Industries to expand sales of separators through adopting the dry method, which has a lower cost than the wet method. Current exposure is roughly 2.5% of revenues, but could reach ~6% in 5 years.
- Furukawa Electric (5801 JP, Neutral): Furukawa Electric is the world's largest producer of copper foil, which is used for making cathodes (conductors) for lithium ion batteries. We expect the size of the copper foil market for lithium ion batteries to be around \$400 million in FY2015, with Furukawa Electric holding a market share of around 50%. Over the next two to three years we do not expect any major impact on earnings, but over the long term see a possibility this business could become a key driver of earnings.
- Mitsubishi Chemical (4188 JP, Neutral): The company is a one-stop supply for anode, electrolyte, and cathode materials. Mitsubishi Chemical plans to establish a new mass-production facility for cathode materials and has been increasing capacity for electrolyte production. We believe they stand to benefit from electric vehicles and will be able to defend margins, even if batteries are commoditized.
- Asahi Kasei (3407 JP, Neutral): The company currently commands a 50%-plus share of the market for consumer-use lithium ion separators. Based on the increasing demand for lithium ion batteries, the company plans to boost separator production capacity. In addition to wet separators, it is developing a dry-type for auto applications. While the company's market share may decline, we believe they will benefit from the long-term growth.

Automotive electronic component makers: We expect the growth of electronic components to take off early, as most automobile companies are unlikely to produce the components themselves. Electronic components makers can utilize their competitive advantages in these areas and there is limited risk of automakers producing them in-house. Specifically, we expect power devices (Rohm) and mid-sized brushless motors (Nidec) to benefit.

- Rohm (6963 JP, Outperform): The company leads in the development of SiC power devices, such as such as inverters and converters, which stand to benefit as power converter equipment is essential to drive electric motors.
- Nidec (6594 JP, Outperform): The company is actively developing electric motors and other components in conjunction with a number of firms. The market for electric motors has increased dramatically, and many auto makes are deciding to not make them in-house.
- ON Semiconductor (ONNN US): ON Semiconductor (ONNN US) is our favorite semiconductor name exposed to the electric vehicle market (22% exposure to autos). Semiconductor chips are contained in hundreds of parts within a vehicle, and represent a ~\$20 billion industry for semiconductors (7.8% of the total industry). Hybrid and pure electric vehicles have roughly twice the semiconductor content than traditional vehicles (~\$600/vehicle compared to ~\$330 for a traditional vehicle).

Auto manufactures and OEMs: In general, Asian and German carmakers have the most robust balance sheets and engineering power in order to be a part of a world with electrical mobility. We see the risk that European and American mass makers will struggle to finance front-up expenditure and if they do, price hiking variable costs to their customers. Besides scale and R&D capabilities, access to battery know how and pricing power will be the core elements of the competitive landscape in our view. Whilst Asian carmakers should benefit from being close to world leading lithium-ion battery know-how, German premium makers should be well positioned to pass on costs. Toyota is a leader

in hybrid technology and Nissan is launching a pure electric vehicle, but both stocks are currently not covered by Credit Suisse research.

- **BYD (1211 HK, Outperform):** Not only is BYD an up and coming auto maker, they have battery expertise and the ability to retain intellectual property. Recently dubbed the underdog in the auto market, they now have 4% of market share (by volume). While not a significant portion of revenue, BYD has launched its all-electric vehicle, which could be well received in the Chinese marketplace.
- **BMW (BMW DE, Outperform):** eMini and Project I are clear examples that BMW is taking EVs very serious. Medium term headwind on BMWs 8-10% autos margin target, but should have pricing power longer-term.
- **Daimler (DAI US, Outperform):** Daimler's 10% stake in Tesla and its JV with Evonik supports their plan to push for electric vehicles. Unlike mass makers, Mercedes should have pricing power to offset some of the add-on costs.
- **Volkswagen (VOWGP DE, Outperform):** VW is currently the strongest OEM globally. It's size and branding power should enable VW to become a leader in EVs. However, the company needs a EU battery supplier in our view.
- **Johnson Controls (JCI US, Outperform):** The company has the largest market share of lead acid batteries and is also developing a lithium ion battery in a partnership with Saft. JCI should benefit from increased production of electric vehicles.

Credit Suisse Electric Vehicle Stock Picks

Exhibit 10: Credit Suisse Electric Vehicle Stock Picks

Sector	Ticker	Company	Market Cap (\$mm)	EV/TTM EBITDA (\$mm)	TTM Sales (\$mm)	Current Exposure	5-year Sales Exposure	Long-term Position	Analyst	12-Month Stock View
Autos	BMW-DE	BMW AG	\$31,725	8.6x	\$69,908	<1%	4%	eMini and Project I show BMW is taking EVs very serious. Medium term headwind on BMWs 8-10% autos margin target, but should have pricing power.	Arndt Ellinghorst	Outperform
Autos	DAI-US	Daimler AG	\$46,335	32.2x	\$110,221	<1%	2%	Daimler's stake in Tesla and its JV with Evonik supports its plan to push for EVs, should have pricing power	Arndt Ellinghorst	Outperform
Autos	VOW-DE	Volkswagen AG	\$66,230	6.6x	\$152,202	<1%	5%	Strongest OEM globally. Size and branding power should enable VW to become a leader in EVs, but still needs a EU battery supplier	Arndt Ellinghorst	Outperform
Autos/Battery	1211-HK	BYD Co. Ltd.	\$18,743	43.5x	\$4,469	<1%	21%	Both Battery & Auto company, exposure to China	Adrian Chan	Outperform
Battery	6752-JP	Panasonic	\$36,267	8.1x	\$74,716	2.4%	4%	Global top share in lithium ion batteries after TOB of Sanyo Electric. Also upwards of 90% market share in NiMH batteries for HEVs.	Koya Tabata	Neutral
Battery	6764-JP	Sanyo Electric	\$4,457	10.9x	\$17,318	1.5%	8%	Current global top share in small lithium ion batteries as well as #2 in automotive NiMH. Will become a subsidiary of Panasonic, for further synergies in energy business.	Koya Tabata	Neutral
Battery/OEM	JCI-US	Johnson Controls Inc.	\$15,446	13.3x	\$29,937	<1%	5%	Among best positioned for EV growth	Chris Ceraso	Outperform
Components	6594-JP	Nidec Corp.	\$11,819	13.8x	\$5,857	2.1%	~15%	Strong position to hold margins on brushless motors	Masashi Itaya	Outperform
Components	6963-JP	Rohm Co. Ltd.	\$8,092	17.0x	\$3,237	<1%	5%	Tailwinds due to strength in critical power components, particularly SiC-based power devices (have superior physical properties versus conventional Si-based power)	Masashi Itaya	Outperform
Materials	3407-JP	Asahi Kasei Corp.	\$7,163	8.4x	\$15,095	1.9%	2.4%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Neutral
Materials	5801-JP	Furukawa Electric	\$2,882	26.2x	\$9,457	1%	2.5%	Largest producer of copper foil for electric vehicles (50% market share)	Shinya Yamada	Neutral
Materials	4023-JP	Kureha Corp.	\$1,123	8.2x	\$1,435	2.1%	4.2%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Outperform
Materials	4188-JP	Mitsubishi Chemical	\$6,279	8.7x	\$27,931	0.5%	1.5%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Neutral
Materials	4208-JP	UBE Industries	\$2,661	9.7x	\$6,507	2.5%	6%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Outperform
Semis	ONNN-US	ON Semiconductor	\$3,402	11.8x	\$1,869	22%	~26%	Semiconductor company with 22% exposure to autos. EVs require roughly twice the dollar amount of semiconductors.	John Pitzer	Outperform

Source: Company data, Credit Suisse estimates

Table of contents

Executive Summary	2
Investment Thesis	4
Credit Suisse Electric Vehicle Stock Picks	7
Back to the Future	9
Electric Vehicles	13
The Basics: What is everyone talking about?	13
Planned Vehicle Models	15
Electric Vehicle Market Potential	16
Do the economics make sense?	19
Potential Adoption Rates	22
Batteries Are Key	28
Battery Supplier Relationships	34
Connecting to the Grid	35
Charging Infrastructure	35
Shifting Economics with Vehicle to Grid Storage	36
Vehicle-to-grid and peak power	38
Investing in Electric Vehicles	41
Stock Picks	45
How will the traditional car business model survive?	53
Entirely New Business Models	55
Appendix: Alternative Solutions	56
Internal Combustion Engines Have Room to Improve	56
Other Ways to Increase Efficiency	61
Appendix: Batteries not the only EV plays	65
Investment stance, valuation	65
Materials, electronic components to offer a more promising earnings contribution than batteries	65
Introducing our eco-car battery forecast model	70
Automotive LiB maker competitive landscape	74
Battery materials supply chain	82
Copper foil market	86
Electronic components: Nidec and Rohm to benefit	88
Drive motors	89
Mid-size brushless motors	90
Power converters (inverters, DC-DC converters)	92
Power devices	93
SiC power devices	95
Risk factors for auto LiB market	98
Appendix: Worldwide Lithium	100
Lithium Uses/End-Markets	100
Energy Storage (20-25% of global lithium market)	100
Global Capacity of Lithium Market	102
Capacity Outlook	108
Demand Outlook for Lithium	109
Lithium S/D Balance and Pricing	113
Supply/Demand Balance Very Loose Without Autos	114
HEV/PHEV/EVs Demand can be Met	115
Appendix: Tax Credits & Incentives	119
Appendix: Li vs. NiMH Batteries	121

Back to the Future

Can consumers get used to travelling in electric cars? Why not, they already have. At the turn of the 20th Century, electric cars were the mode of choice for consumers who wished to travel by horseless carriage. The electric vehicle was quite fashionable in France, which coined the term automobile from the Greek word for self and the Latin term for moving. It did not require a hand crank to get started, nor a messy gear change, had no smell, less pollution and were quieter than gas powered engines. As intra city travel was well in the future, the more limited range of electric vehicles at the time was not an issue. So if one travelled back in time 110 years ago, one would have found that the majority of cars on the road were electric, powered by a battery.

The decline of the electric car and the success of the gas powered car have been well documented, with a combination of cheap oil and hence gas, the invention of the electric starter and Henry Ford's internal combustion engine all contributing to the changeover.

So as we now look at the future of the electric vehicle, one can think of it as Back to the Future, as not only have we been there, but with the right decisions 100 years ago, we may still be there.

That raises the question of what will the future look like. Will it be a world of owning or leasing everything but the battery, which will be swapped out in super fast speed when one drives through a battery changing station? That is the approach being suggested by Better Place. Will companies develop solar powered parking lots so their employees can be charging their cars and supplying power back to the utility at peak times before they drive home? Will all future homes be built with a high voltage power plug to speed recharging? Will smart grids be developed to manage when vehicles can charge? Will the storage advantages of battery technology become so overwhelming that the electricity savings and peak load shaving efforts offset much of the additional costs of the battery?

We wish we had all these answers but at this stage we don't, as in many countries politics may play as important a role as economics. However, what we can calculate is the economics of the electric car, which we find quite compelling, and when one adds to that the potential CO₂ benefits as well as the security considerations, we have no doubt that some form of either all electric (EV) or hybrid electric (HEV) transport will grow rapidly in the next decade. Analyzing that potential growth, looking at its impact on oil demand, auto manufacturers, raw material suppliers and battery manufacturers is the focus of this report. As we detail inside, investable ideas at this stage evolve around the battery companies but others that get impacted both positively and negatively are discussed as well.

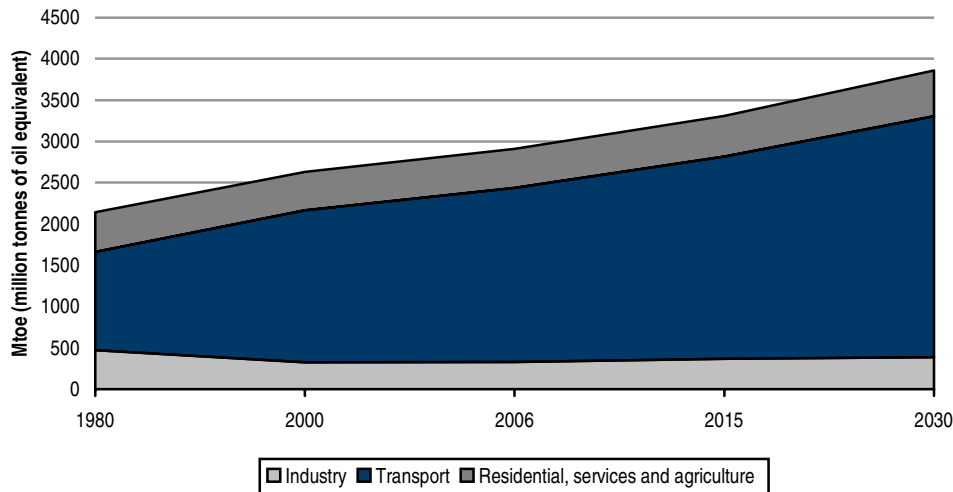
Hooked on Oil

The push to electric vehicles and to improving CAFE standards is one of the most supported moves in western industrialized countries as well as in China and India. Why? Currently the transportation sector accounts for over 30% of the world's energy consumption and nearly 72% of the global oil demand. That clearly makes it one of the largest causes of global warming and a target of those wishing to reduce CO₂ emissions. However, the source of oil, with imports primarily from Middle East countries and other countries viewed as less friendly to democracies, adds a security concern to the global warming issue and unites politicians on both sides of the aisle (in the democracies) that something need be done. This in turn adds very important funding and political support to the equation, something that even solar and wind do not fully have. That is one of the reasons behind our confidence that we will see electric cars grow faster than many currently believe.

Some would argue that we can achieve much of the savings of electric vehicles by creating more efficiency in the internal combustion engine and by other less expensive measures. In fact, later in this report, we include a counterpoint argument from our US auto analyst, Chris Ceraso, arguing that very thing. However, energy efficiency of the

transportation sector has not materially increased in the last two decades. With the stabilization of the US CAFE standard in 1990, the fuel efficiency of vehicles reached a plateau of roughly 25 MPG. It may seem that we can tell everyone to inflate their tires and that will get us as far as 10% of the fleet being electric vehicles. As well, becoming more efficient may not offset the rising demand for oil in the developing world as we discuss below. To lessen the dependence on oil, especially as developing countries strain supplies, there will need to be an answer to our transportation efficiency dilemma. Electric vehicles, which use no oil to run, offer a compelling solution, even if in concert with efficiency programs.

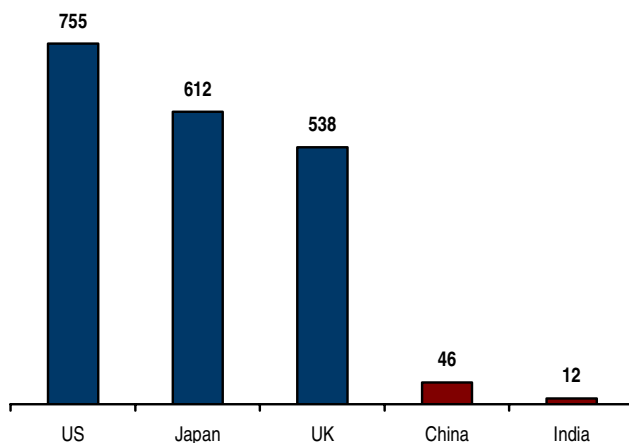
Exhibit 11: World oil consumption by sector, without vehicle electrification



Source: EIA, Company data, Credit Suisse estimates

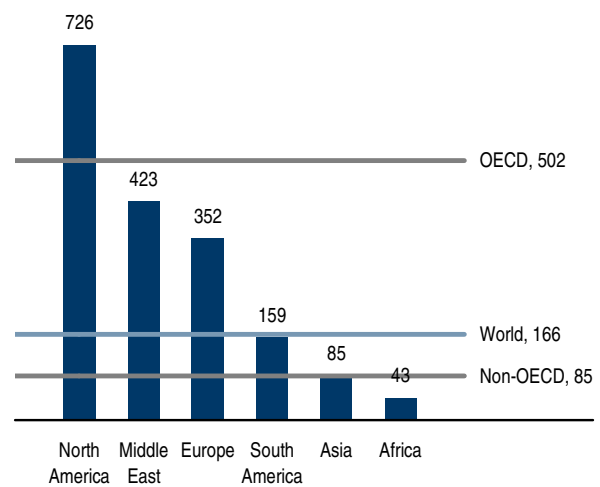
What will happen as China and India, with their massive populations, begin to demand more automotive transportation? All current signs point to oil prices rising again in the future. While countries such as China and India continue to become wealthier and as their economies expand, putting more strain on global oil supplies. Additionally, some geologists and oil companies have seen evidence of peaking oil production. Whether that is in 50 years or 200, it will become a meaningful obstacle sometime in the future.

Figure 12: Vehicles per 1000 people



Source: EIA, Credit Suisse estimates

Figure 13: Gallons of Oil Consumed per Capita



Source: EIA, Credit Suisse estimates

While improvements in fuel efficiency are part of the solution, electric vehicles offer the most potential, at least when you look at the per-vehicle emissions. Electric transportation is the most efficient and least polluting, even when compared with diesel, hybrid gasoline, hydrogen, and natural gas vehicles. Using a well-to-wheel measure of efficiency, electric vehicles are more than twice as efficient. Additionally, they generate the least amount of CO₂ per distance travelled, even when you consider the emissions from generating the power from the current fleet of power plants.

Figure 14: Per-vehicle Energy Efficiency & Greenhouse Gas Emissions: Electric Vehicles Offer Best Solution

Technology	Well-to-Wheel Efficiency	Technology	GHG Emissions
Electric Vehicle	1.14 km/MJ	Electric Vehicle	0.07 kg CO ₂ /km
Hybrid (Gas/Electric)	0.50 km/MJ	Hydrogen Fuel Cell	0.10 kg CO ₂ /km
Diesel Engine	0.36 km/MJ	Hybrid (Gas/Electric)	0.11 kg CO ₂ /km
Hydrogen Fuel Cell	0.35 km/MJ	Diesel Engine	0.19 kg CO ₂ /km
Gasoline Engine	0.29 km/MJ	Gasoline Engine	0.19 kg CO ₂ /km
Natural Gas Engine	0.27 km/MJ	Natural Gas Engine	0.23 kg CO ₂ /km

Source: Credit Suisse estimates, Tesla Motors, DEFRA, EIA, Argonne, Company Data

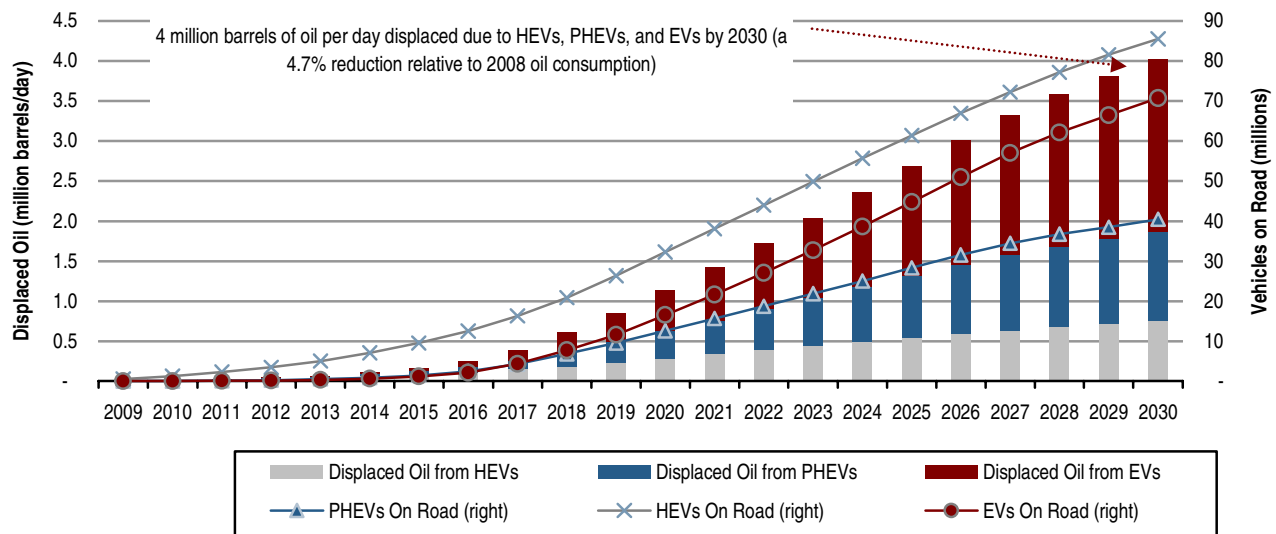
Note: Assumes electric vehicles use current fleet of power generation (coal, gas, nuclear, etc)

While the per-vehicle emissions suggest electric vehicles are the best way to reduce greenhouse gas emissions, this isn't necessarily the case. Small improvements in current gasoline vehicle technology can be immediately incorporated into the majority of vehicles that are produced at a reasonable cost. Electric vehicles, however, would require very high penetration rates to result in the same overall greenhouse gas reductions.

For example, if the penetration rate of EVs reaches, say, 2% of global vehicle sales by 2012, we estimate that the total reduction in fuel consumption could be in the neighborhood of 20.8 million barrels of petroleum per year. By contrast, if we assume that the remaining 98% of vehicles sold achieve a fuel economy improvement of 10% - through a combination of engine downsizing, turbocharging, and other existing technologies to make engines and transmissions more efficient – the total reduction in global fuel use would add up to an estimated 92.5 million barrels of petroleum per year.

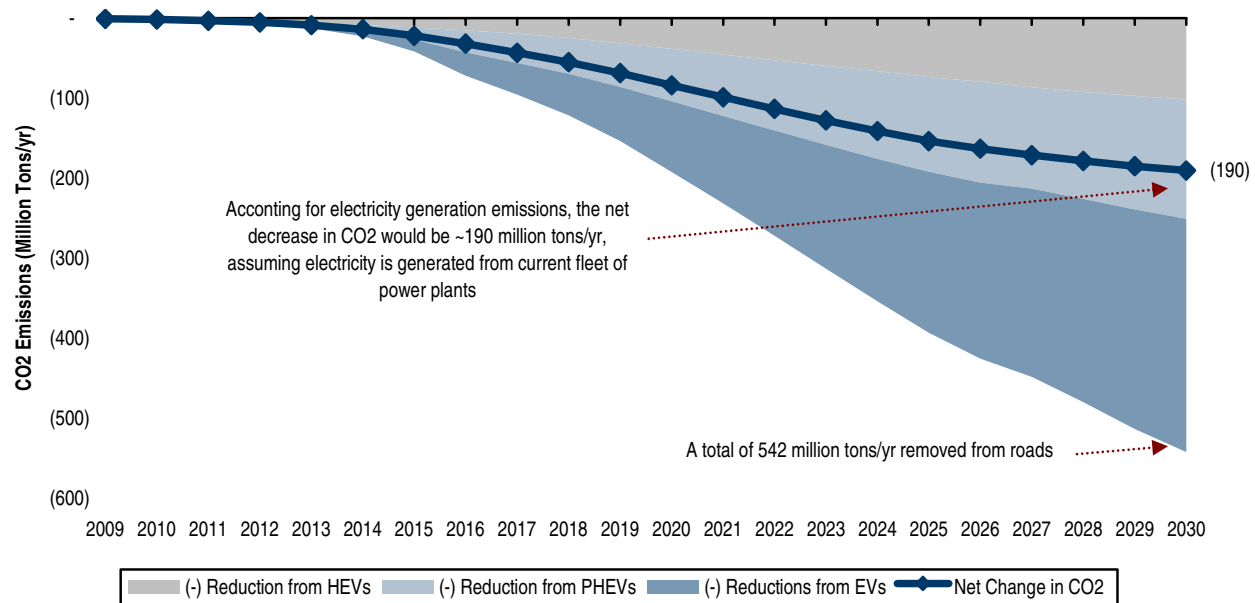
What does this mean for the future of electric vehicles? Auto manufacturers will address the need to meet CAFE standards with improvements to current internal combustion engine technologies and shifting the mix to smaller or lighter vehicles. Electric vehicles will be part of the puzzle, but not the driving force to reduce carbon emissions. Hence, we focus on the economics of electric vehicles to gauge potential adoption instead of the notion that governments will be forced to switch to electric vehicles to meet CAFE standards.

If electrified vehicles gain popularity, as we expect, there would be a worldwide reduction in gasoline consumption of 59.9 million gallons per day by 2020 and 168.9 million gallons per day by 2030. While we are simplifying the market dynamics, this could equate to a reduction of ~4 million barrels of oil per day, representing a 4.7% reduction from consumption levels in 2008. As the following graph illustrates, the savings are roughly split between plug-in electric vehicles (PHEV) and hybrid electric vehicles (HEV), with pure electric vehicles (EV) providing the most significant reductions. We discuss the differences between the technologies in the following section.

Exhibit 15: Oil Consumption Decreases by 4 million barrels per day

Source: Credit Suisse estimates

If we assume the electric vehicles are purchased instead of efficient internal combustion engine vehicles (with efficiencies of 32 MPG), the *incremental* impact of HEVs, PHEVs and EVs is significant: CO₂ emissions would be reduced by 190 million tons per year, even if you generate electricity from the current power plants in each country. Every gallon of gasoline emits 19.4 pounds of CO₂ when burned. Excluding the impacts of generating electricity (or if it would come from renewables sources), emissions of CO₂ would be cut by nearly half a billion tons. To put things in perspective, the net reduction of 190 million tons is about 0.7% of current global emissions from all sources. As previously discussed, changes to the entire fleet of vehicles would be more effective in reducing emissions near-term.

Exhibit 16: Net Carbon Dioxide Reductions

Source: Credit Suisse estimates

Electric Vehicles

The Basics: What is everyone talking about?

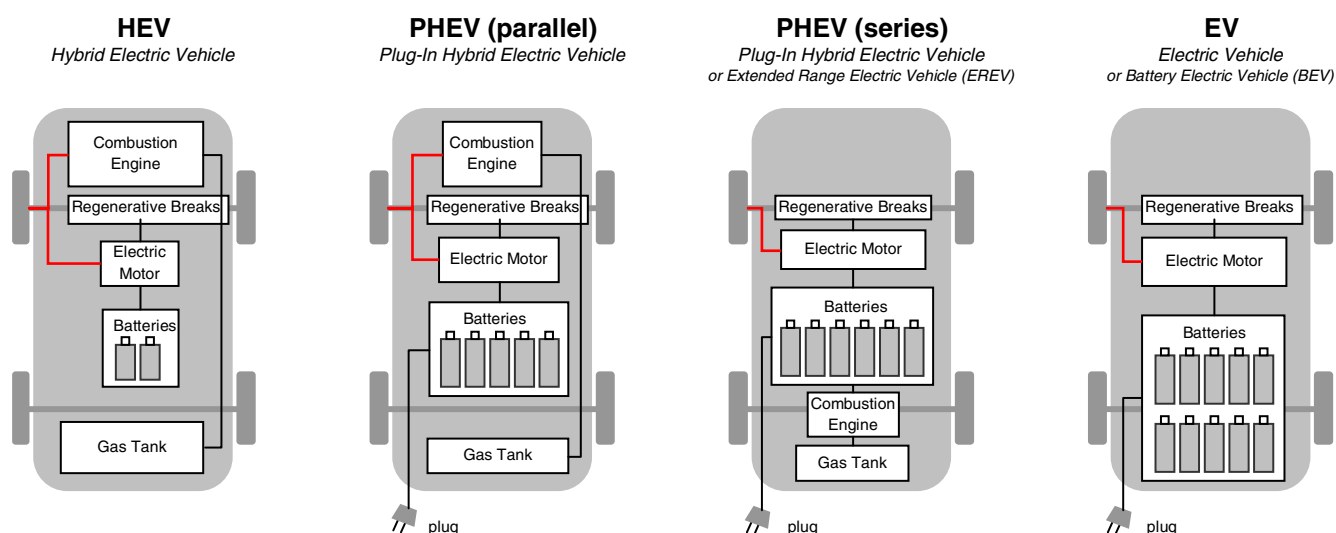
Politicians, the press, and environmentalists are talking about electric vehicles, hybrid electric vehicles, and even plug-in hybrid electric vehicles. But what is what? There are fundamental differences between the vehicles.

The vast majority of “hybrid vehicles” today, such as the Toyota Prius, are classified as **Hybrid Electric Vehicles (HEVs)**. They use both an internal combustion gas engine and an electric motor, offering fuel efficiency of 50 mpg or better in some cases. The HEV stores power in the battery that would otherwise be lost during braking. These generally use a medium-size nickel-metal hydride battery to power a small electric motor. For faster speeds, the gasoline engine is used. HEVs do not “plug in” to electric outlets.

Plug-In Hybrid Electric Vehicles (PHEVs) provide a significant electric-only range but also contain a combustion engine to extend the range. The difference between PHEV and HEVs is that PHEVs can plug into normal electric outlets to charge the batteries and also have much larger batteries. PHEVs come in two varieties: Parallel PHEVs and Series PHEVs. Parallel PHEVs use the internal combustion engine to provide range extension by directly connecting to the wheels. Series PHEVs, on the other hand, only use the internal combustion engine to generate electricity to recharge the batteries – only the electric motor is used to provide propulsion. These are often called “range extended” electric vehicles. The GM Volt, for example, is a Series PHEV, which can go ~40 miles just on electricity and then will use the internal combustion engine to sustain the battery’s charge.

Electric Vehicles (EVs) use an electric motor for propulsion and do not have an internal combustion engine. These vehicles have the most stringent requirements for battery technologies, as there is no backup energy source. For this reason, in addition to the high cost of batteries, EVs are generally considered to be less viable for mainstream consumer cars, especially without a public charging infrastructure. There does seem to be some growing interest in EVs in Europe, especially in areas where it would be less expensive to install a charging network or battery switching stations. That said, if a charging infrastructure is built and battery costs decline, pure EVs may be the best option.

Exhibit 17: Diagram Overview of Vehicle Technologies



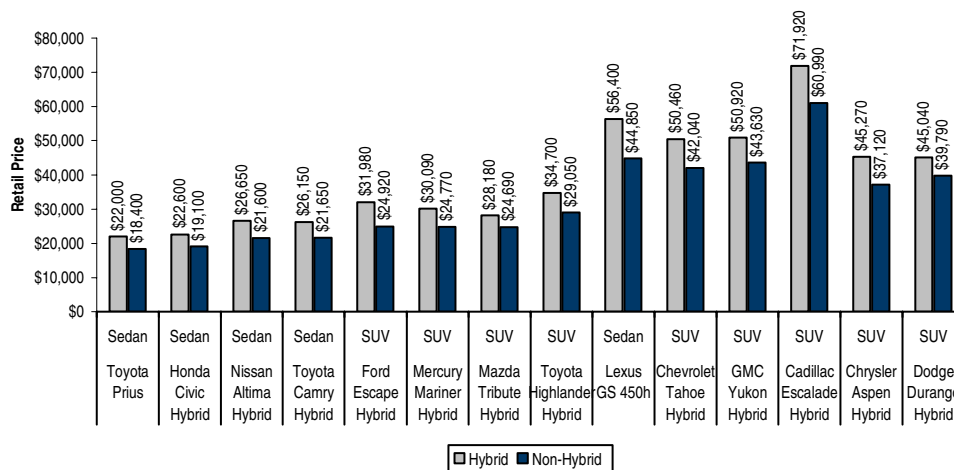
Source: Credit Suisse Research, parts adopted from Electric Drive Transportation Association

Exhibit 18: Pros and Cons of Electric Drive trains

	Positives	Negatives
HEV	- Average of 30% less CO2 emissions 15%-44% more fuel efficient - Batteries don't require high storage capacity - Up to \$3,400 tax credit (U.S.) - Battery degradation presents less problems	- Tailpipe emission indispensable - Tax credits not eligible anymore for Toyotas and Hondas - Only more cost effective when oil prices rise - High battery costs
EV	- Zero tailpipe emissions - Up to \$7,500 tax credit (U.S.) - Very low energy costs - No costs for combustion engine - Vehicle-2-Grid capability - Energy source can come from renewables	- Limited driving range, 100-200 miles (max) - Very high battery costs - Only more cost effective when oil prices rise sharply - Dependant on grid plug-in station - Long battery recharging time
PHEV	- Potentially zero tailpipe emissions - High driving range - Low energy costs - Up to \$7,500 tax credit (U.S.) - Vehicle-2-Grid capability - Primary energy source can come from renewables	- Carries two engines - Very high battery costs - Long battery recharging time - Only more cost effective when oil prices rise sharply
FCEV	- Zero tailpipe emissions - Very high potential for the future	- Today hydrogen production has high lifecycle emissions - Technology isn't fully developed yet - Technology is still very expensive

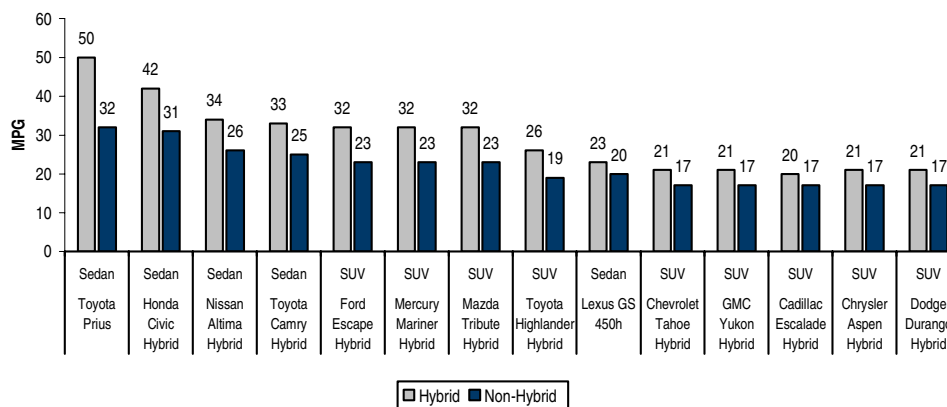
Source: Company data, Credit Suisse estimates

Exhibit 19: ICE vs. HEV price comparison: average price premium of 20%



Source: Company data, Credit Suisse estimates, MPG data from fueleconomy.gov

Exhibit 20: MPG Comparison, ICE vs. HEV: average MPG improvement of 31%



Source: Company data, Credit Suisse estimates, MPG data from fueleconomy.gov

Planned Vehicle Models

Exhibit 21: HEV, PHEV and EV Models

Hybrid Vehicles

Company	Model	Price	Battery Type	Battery Size	Blended MPG	Latest Model	Market launch	US Sales (2008)	Battery Supplier
BMW	X6 Hybrid	-	NiMH	-	21	2009	2009		Panasonic
BMW	7 Series Hybrid	-	Lithium-ion	-	-	2009	2009		Johnson Controls + Saft ABS
Chery	A5 Hybrid	-	NiMH	-	42	2008	2008		Johnson Controls + Saft ABS
Chrysler	Aspen Hybrid	-	NiMH	-	19	2009	2008	46	Panasonic
Chrysler	Dodge Durango Hybrid	-	NiMH	-	19	2009	2008		Panasonic
Daimler	Mercedes S400 Hybrid	-	Lithium-ion	0.7 KWh	29	2009	2009		Johnson Controls + Saft ABS
Daimler	Mercedes ML 450 Hybrid	-	NiMH	2.4 KWh	22	2010	2009		Cobasys
Ford	Escape Hybrid	-	NiMH	-	32	2008	2004	17,193	Sanyo / Panasonic
Ford	Fusion Hybrid	-	NiMH	-	39	2010	2009		Sanyo / Panasonic
Ford	Mercury Mariner Hybrid	-	NiMH	-	32	2009	2006		Sanyo / Panasonic
Ford	Mercury Milan Hybrid	-	NiMH	-	39	2010	2009	2,329	Sanyo / Panasonic
GM	Cadillac Escalade Hybrid	-	NiMH	-	20	2009	2007	801	Panasonic
GM	Chevrolet Silverado Hybrid	\$38,020	NiMH	-	21	2009	2008		Panasonic
GM	Chevrolet Tahoe Hybrid	\$50,455	NiMH	1.8 KWh	21	2008	2007	4,088	Panasonic
GM	GMC Sierra Hybrid	\$38,390	NiMH	-	21	2009	2008		Panasonic
GM	GMC Yukon Hybrid	\$50,920	NiMH	-	21	2008	2007	2,356	Panasonic
GM	Chevrolet Malibu Hybrid	\$25,555	NiMH	-	28	2008	2008	2,388	Panasonic
GM	Saturn Vue Green Line	-	NiMH	-	30	2009	2006	3,067	Cobasys
Honda	Civic Hybrid	\$23,650	NiMH	1.3 KWh	42	2009	2003	31,297	Sanyo / Panasonic
Honda	Fit Hybrid	-	NiMH	-	50	2010	2010		Sanyo / Panasonic
Honda	Insight	\$19,800	NiMH	0.6 KWh	41	2010	2009		Sanyo / Panasonic
Hyundai	Accent Hybrid	-	Li polymer	-	45	2009	2009		LG Chem
Hyundai	Sonata Hybrid	-	Li polymer	-	31	2010	2010		LG Chem
Lexus	GS 450h	\$56,550	NiMH	1.3 KWh	23	2007	2007	678	Panasonic
Lexus	LS600h/LS 600hL	\$106,035	NiMH	-	21	2008	2008	980	Panasonic
Lexus	RX 400h	\$41,660	NiMH	-	25	2005	2005	15,200	Panasonic
Lexus	HS 250h	-	NiMH	-	>32	2010	2010		Panasonic
Mazda	Tribute Hybrid	-	NiMH	-	32	2009	2007		Sanyo / Panasonic
Nissan	Altima Hybrid	-	NiMH	-	34	2009	2003	8,819	Panasonic
Porsche	Cayenne Hybrid	-	NiMH	-	25	2010	2010		Sanyo / Panasonic
Toyota	Camry Hybrid	-	NiMH	-	33	2007	2007	46,272	Panasonic
Toyota	Highlander Hybrid	-	NiMH	-	26	2008	2006	19,391	Panasonic
Toyota	Prius	\$22,000	NiMH	1.3 KWh	50	2010	1997	158,884	Panasonic
Volkswagen	Touareg	-	NiMH	1.7 KWh	31	2010	2010		Sanyo / Panasonic

Plug-In Hybrid Electric Vehicles

Company	Model	Price	Battery Type	Battery Size	EV Range (miles)	PHEV Type	Market launch	Production Capacity	Battery Supplier
BYD	F3DM	\$21,915	Lithium-ion	-	62	-	2008		BYD
BYD	F6DM	~\$22,000	Lithium-ion	-	62	-	2008		BYD
Fisker	Karma	\$87,900	Lithium-ion	22 KWh	50	Series	2010	15k	letter of intent with EnerDel
Ford	Escape PHEV	-	Lithium-ion	10 KWh	30-40	-	2012		Johnson Controls + Saft ABS
GM	Chevrolet Volt	~\$40,000+	Lithium-ion	16 KWh	40	Series	2010	60k by 2012	LG Chem
Opel	Ampera	-	Lithium-ion	16 KWh	40	Series	2012		LG Chem
Toyota	Prius	~\$48,000	Lithium-ion	-	12-18	Parallel	2010	20k-30k	Panasonic, potentially Sanyo
Volkswagen	Golf Twin Drive	-	Lithium-ion	12 KWh	30	-	2010	20 car pilot	Evonik

Electric Vehicles

Company	Model	Price	Battery Type	Battery Size	EV Range (miles)	Latest Model	Market launch	Production Capacity	Battery Supplier
BMW	Mini E	-	Lithium-ion	35 KWh	~100+	2009	n.d.	500 pilot	AC Propulsion
BYD	E6 EV	-	Lithium-ion	18 KWh	249	2009	2009		BYD
Chery Auto.	S18 EV	~\$15,000	Lithium-ion	13 KWh	93	2009	2009		Chery Quantum Auto Co.
Chrysler	Dodge circuit	-	Lithium-ion	26 KWh	150-200	2010	2010		A123
Coda	EV Sedan	\$45,000	Lithium-ion	34 KWh	90-120	2010	2010		Tianjin Lishen Battery Joint-Stock
Ford	Focus EV	-	Lithium-ion	-	100	2011	2011		Magna Steyr / A123
Mitsubishi	iMiEV	~\$46,000	Lithium-ion	16 KWh	100	2009	2009	20,000	GS Yuasa
Nissan	EV LEAF	~\$24k to ~\$34k*	Lithium-ion	24 KWh	100	2010	2010	150,000+	NEC
Renault	Fluence ZE (Better Place)	-	Lithium-ion	-	100	2011	2011	100,000	AESC / A123
Smart	EV	-	Lithium-ion	-	70	2010	2010		Tesla/Li-Tec
Subaru	Stella	\$47,900	Lithium-ion	9 KWh	55	2009	2009	~170 in 2009	NEC / AESC
Tesla	Model S	\$57,400	Lithium-ion	-	160-300	2011	2011		Tesla
Tesla	Roadster EV	\$109,000	Lithium-ion	53 KWh	244	2009	2009		Tesla
ThInk	City	\$28,000	Sodium or Li	-	110	2010	2010	2,500 (US)	Mes-Dea, A123, EnerDel

Source: Company data, Credit Suisse estimates

Electric Vehicle Market Potential

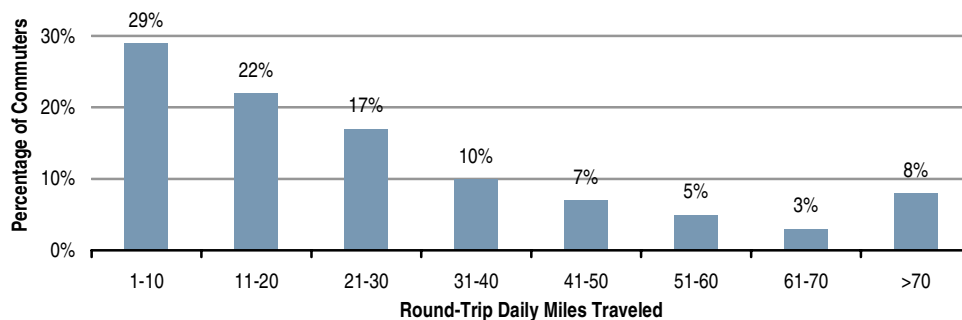
Even if the economics make sense, will consumers be willing to purchase an electric vehicle? The hybrids that are currently on the road have been well received by consumers, but the lithium ion technologies that will power the next generation of PHEVs and EVs present new limitations, primarily range, that may impact consumers' decisions. According to the U.S. Bureau of Transportation, nearly 78% of Americans commute less than 40 miles each day, less than the expected battery-only range of most PHEV models. However, how many consumers will be comfortable knowing that an extended trip may leave them without a way to get home in an EV or PHEV. We don't dismiss this point, as consumers will be hesitant if they feel there is any limitation.

That said, in the early years, especially as the economics begin to make sense, there will be subsets of consumers that are not impacted by a limited range. Specifically, there will be consumers that purchase PHEVs or EVs as a secondary car, for their daily commutes or city driving. Secondly, there will be commercial fleet vehicles, which have a set daily route and a central charging station every evening. These customers, which will likely be the early adopters, are influenced by the total cost of ownership, which is the main selling point for electric vehicles.

PHEVs may be a good transition vehicle, as they provide extended ranges. The Chevy Volt is envisaged to have an electric capacity of 40 miles before the gasoline charger kicks in. There are already cars in Japan that offer greater electric-only range. Mitsubishi launched a pure electric vehicle called iMiEV in July which has a range of up to 100 miles and a top speed of 81 miles per hour. Mitsubishi has developed its own lithium ion battery in a joint venture with GS Yuasa. Nissan has also launched the LEAF (100 mile electric range). These ranges are sufficient to satisfy the vast majority of consumers.

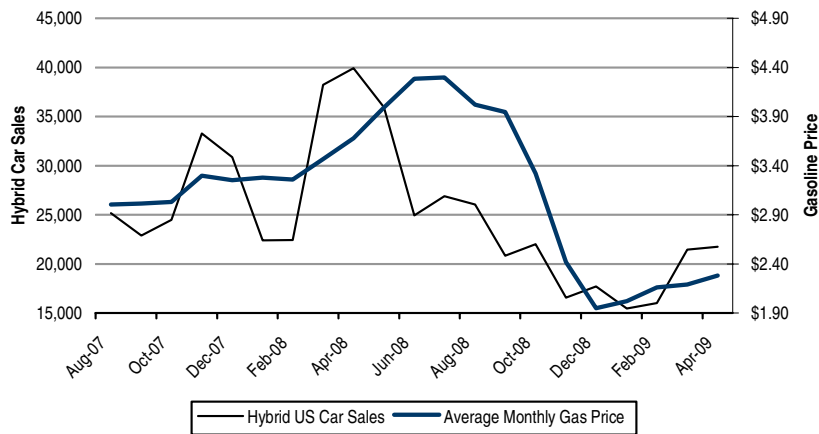
These statistics are similar in other countries, with even shorter commutes for urban areas.

Exhibit 22: Typical Commute Distance



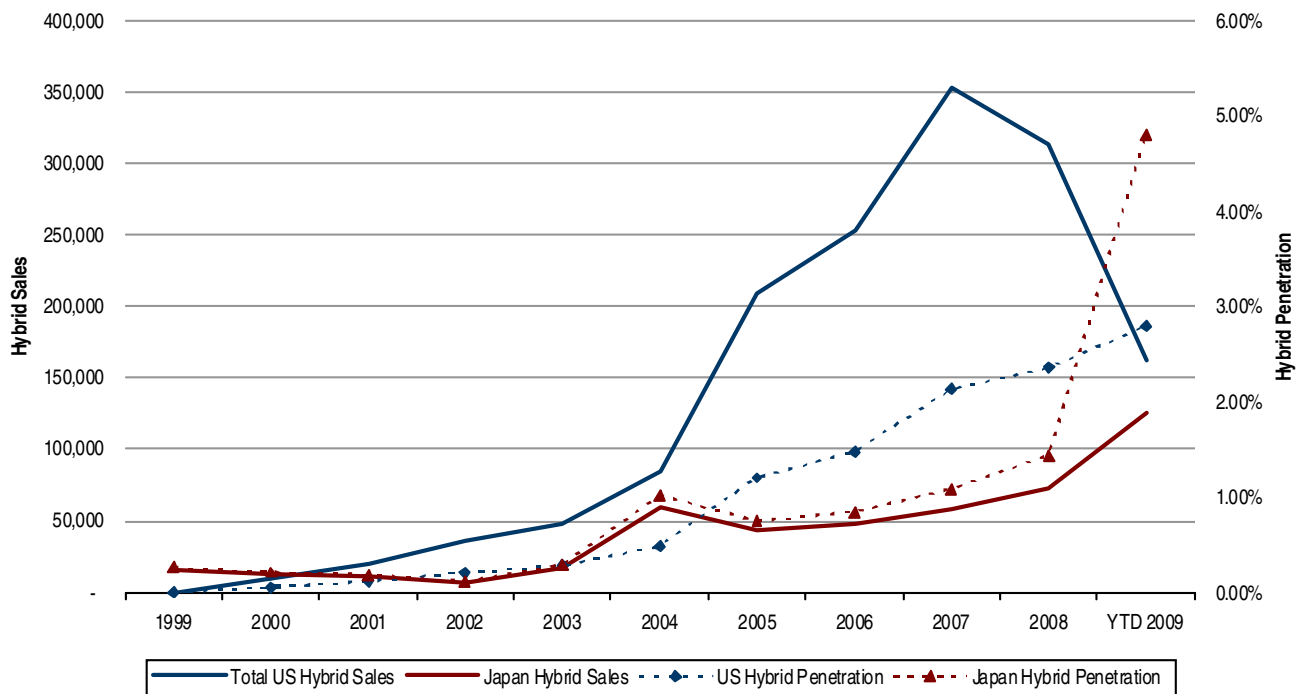
Source: U.S. Bureau of Transportation, EPRI

We can also look to historic HEV adoption to see how new technologies are embraced and what drives their sales. The HEV sales in the United States are, not surprisingly, highly correlated with the price of gasoline. Despite the large decline in sales, the U.S. market is still the biggest HEV market globally, but Japan is growing rapidly – **in June, Japan's hybrid sales reached an 8% penetration rate.** Through July 2008, more than 162 thousand hybrids were sold in the US (2.8% penetration rate). We expect hybrid sales in Europe also to increase when costs become more competitive.

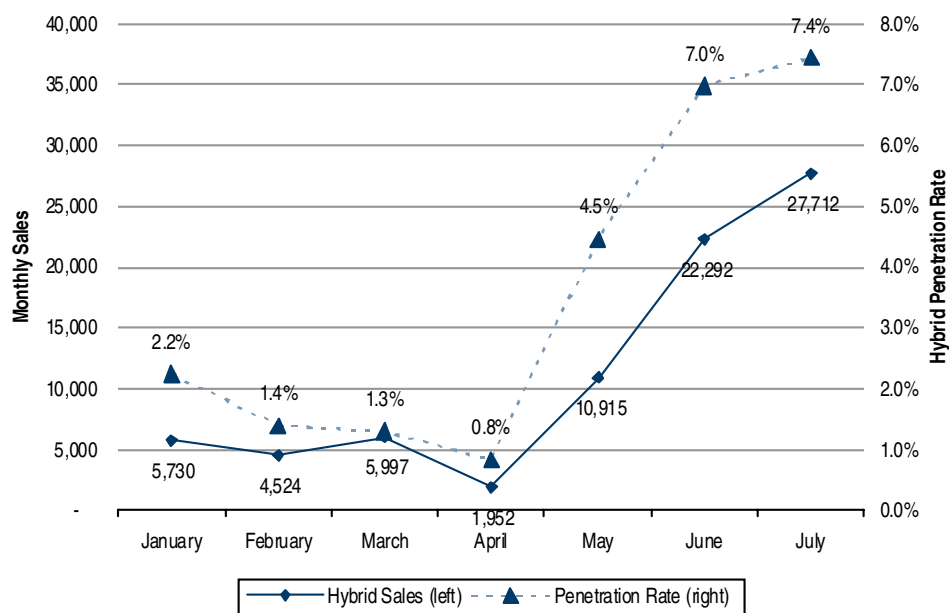
Exhibit 23: Hybrid Car Sales vs. Gasoline Prices

Source: EIA, Company data, Credit Suisse estimates

Japan recently introduced additional incentives to purchase HEVs. Sales of HEVs have since climbed dramatically – the penetration rate of HEV sales is now ~5% YTD in Japan (8% in July). US sales declined with overall economic conditions, but the penetration rate continued to increase. When forecasting adoption rates and trends, it is useful to look back at HEV adoption. It was largely a function of (1) environmentally motivated adopters, (2) having models available on the market, (3) fuel prices, (4) growth due to wider acceptance.

Exhibit 24: US & Japan Hybrid Adoption

Source: Company data, JAMA, Credit Suisse estimates

Exhibit 25: Acceleration in Japan due to Subsidies

Source: JAMA, Company Data, Credit Suisse Estimates

Do the economics make sense?

This brings us back to the question of whether or not electric vehicles actually make economic sense to own. While we expect that there will be a group of early adopters, much as we have seen with hybrids, consumers who will pay very uneconomical prices for environmental or other reasons to buy electric vehicles. However, costs will likely be the driver for the vast majority of consumers.

The battery alone for a plug-in hybrid vehicle adds at least \$9,000 to the cost of the car and that already assumes economies of scale are achieved. Given the varying tax credits and fuel taxes, we present a sensitivity table that shows how low the battery price would have to be (per KWh) before PHEVs or EVs make economic sense. The regions where they are currently economic are shaded green, while areas that we do not expect to be economic (even at long-term battery prices of \$500/KWh) are shaded in red.

Exhibit 26: PHEV & EV Breakeven Tables

		Tax Credit Per PHEV Sold							Tax Credit Per EV Sold				
		\$0	\$2,500	\$5,000	\$7,500	\$10,000			\$0	\$2,500	\$5,000	\$7,500	\$10,000
Gasoline Price (\$/Gallon)	\$2.00	-\$65	\$185	\$435	\$685	\$935	Gasoline Price (\$/Gallon)	\$2.00	\$263	\$388	\$513	\$638	\$763
	\$2.50	\$105	\$355	\$605	\$855	\$1,105		\$2.50	\$358	\$483	\$608	\$733	\$858
	\$3.00	\$274	\$524	\$774	\$1,024	\$1,274		\$3.00	\$453	\$578	\$703	\$828	\$953
	\$3.50	\$444	\$694	\$944	\$1,194	\$1,444		\$3.50	\$548	\$673	\$798	\$923	\$1,048
	\$4.00	\$614	\$864	\$1,114	\$1,364	\$1,614		\$4.00	\$643	\$768	\$893	\$1,018	\$1,143
	\$4.50	\$784	\$1,034	\$1,284	\$1,534	\$1,784		\$4.50	\$739	\$864	\$989	\$1,114	\$1,239
	\$5.00	\$954	\$1,204	\$1,454	\$1,704	\$1,954		\$5.00	\$834	\$959	\$1,084	\$1,209	\$1,334
	\$5.50	\$1,124	\$1,374	\$1,624	\$1,874	\$2,124		\$5.50	\$929	\$1,054	\$1,179	\$1,304	\$1,429
	\$6.00	\$1,293	\$1,543	\$1,793	\$2,043	\$2,293		\$6.00	\$1,024	\$1,149	\$1,274	\$1,399	\$1,524

Key	
Economic with today's battery costs (\$1,200 per KWh)	
Expected to be economic in 2012 (battery price of \$900 per KWh)	
Not Economic, even at long-term target (\$500 per KWh)	

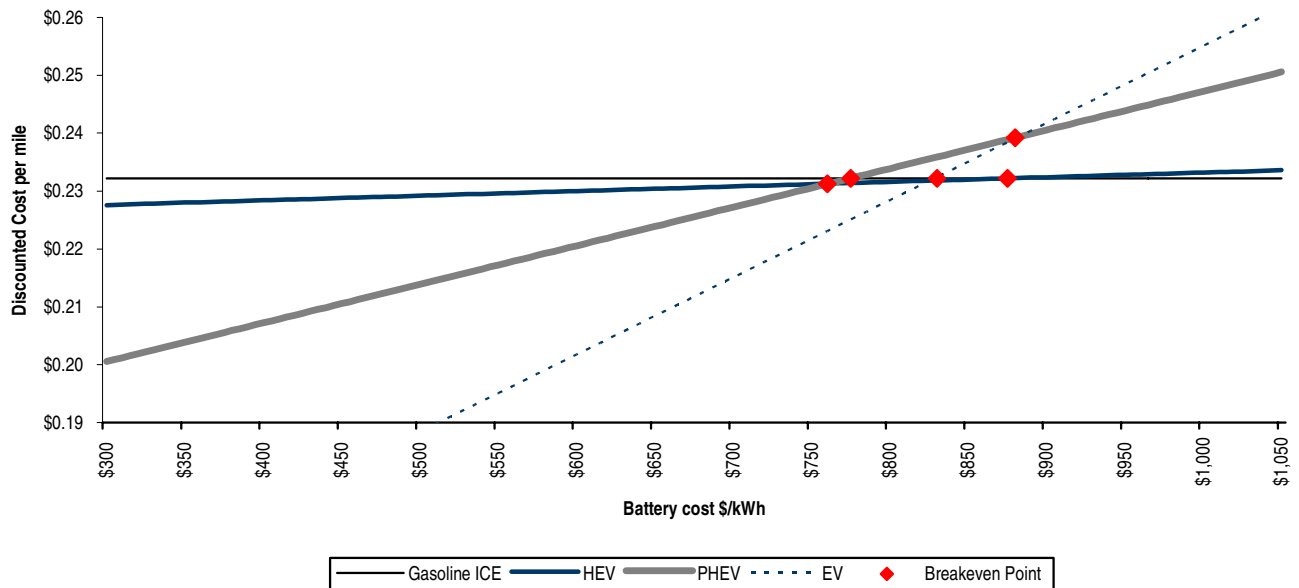
Source: Credit Suisse estimates

Scenario 1: \$3/gallon Gas, Hefty Tax Credits

The following calculations show that battery prices of \$774/kWh would make PHEVs competitive with internal combustion engines, assuming you get tax credits and gas remains at current prices (~\$3/gallon).

Exhibit 27: Battery Breakeven Prices, assuming \$3/gas & current incentives

Assumptions			Gasoline	Diesel	HEV	PHEV	EV
Annual mileage	15,000	Base Car Price	\$ 18,500	\$ 19,500	\$ 20,500	\$ 22,000	\$ 18,000
Lifecycle (years)	10	Battery Costs	\$ -	\$ -	\$ 1,440	\$ 12,000	\$ 24,000
Fuel efficiency (mpg) Gas ICE	32	Tax Credit	\$ -	\$ -	\$ -	\$ 5,000	\$ 7,500
Fuel efficiency (mpg) Diesel ICE	38	Purchase Costs	\$ 18,500	\$ 19,500	\$ 21,940	\$ 29,000	\$ 34,500
Fuel efficiency (mpg) HEV	45	Annual Fuel Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 150	\$ -
Fuel efficiency (mpg) ICE of PHEV	60	Annual Electricity Costs	\$ -	\$ -	\$ -	\$ 426	\$ 532
PHEV Gas ratio	20%	Annual Maintenance	\$ 607	\$ 607	\$ 637	\$ 668	\$ 425
Gasoline Price (\$/gal)	\$ 3.00	Annual Variable Costs	\$ 2,013	\$ 1,594	\$ 1,637	\$ 1,243	\$ 957
Diesel Price (\$/gal)	\$ 2.50						
Battery Price (\$/kWh) - Current	\$ 1,200						
HEV Battery Size (kWh)	1.2	Total Discounted cost	\$ 34,829	\$ 32,427	\$ 35,220	\$ 39,084	\$ 42,261
PHEV Battery Size (kWh)	10	Cost per Mile	\$ 0.232	\$ 0.216	\$ 0.235	\$ 0.261	\$ 0.282
EV Battery Size (kWh)	20						
Electricity Price (\$/kWh)	\$ 0.11	Breakeven Points					
Battery mileage (miles/kWh)	3	Max Battery Price (vs. Gasoline ICE)			\$874/kWh	\$774/kWh	\$828/kWh
Discount Rate	4%	Max Battery Price (vs. Diesel ICE)			-\$1,127/kWh	\$534/kWh	\$783/kWh



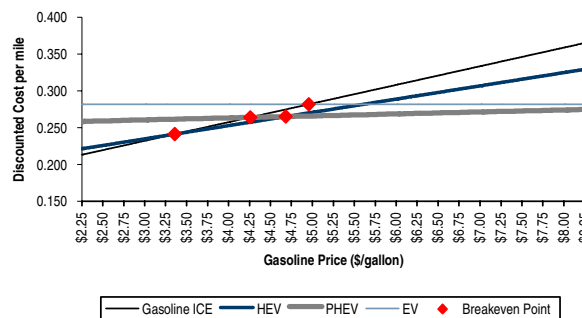
Source: Credit Suisse estimates

Scenario 2: Today's battery costs & tax credit

At today's battery prices (\$1,200/KWh), gasoline prices would need to rise to an effective price of \$3.36 to make HEVs economically attractive. With tax credits, and at today's battery prices, PHEVs make economic sense at gas prices over \$4.25. Pure electric vehicles make sense when gas costs \$4.95.

Exhibit 28: Scenario 2

	Gasoline	Diesel	HEV	PHEV	EV
Base Car Price	\$ 18,500	\$ 19,500	\$ 20,500	\$ 22,000	\$ 18,000
Battery Costs	\$ -	\$ -	\$ 1,440	\$ 12,000	\$ 24,000
Tax Credit	\$ -	\$ -	\$ -	\$ 5,000	\$ 7,500
Purchase Costs	\$ 18,500	\$ 19,500	\$ 21,940	\$ 29,000	\$ 34,500
Annual Fuel Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 150	\$ -
Annual Electricity Costs	\$ -	\$ -	\$ -	\$ 426	\$ 532
Annual Maintenance	\$ 607	\$ 607	\$ 637	\$ 668	\$ 425
Annual Variable Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 576	\$ 532
Total Discounted cost	\$ 29,906	\$ 27,504	\$ 30,051	\$ 33,669	\$ 38,815
Cost per Mile	\$ 0.199	\$ 0.183	\$ 0.200	\$ 0.224	\$ 0.259
Breakeven Points					
Min Gas Price (vs. Gasoline ICE)			\$3.36/gal	\$4.25/gal	\$4.95/gal
Min Diesel Price (vs. Diesel ICE)			\$5.39/gal	\$4.81/gal	\$5.57/gal



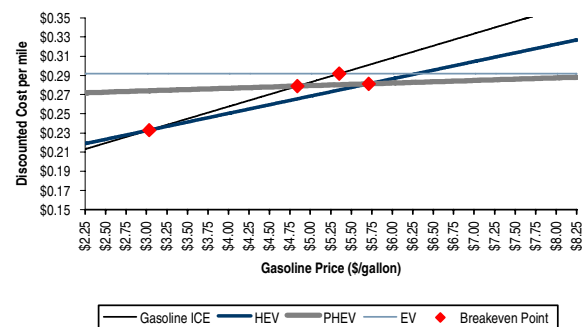
Source: Credit Suisse estimates

Scenario 3: Battery costs fall to near-term target, no tax credits

Should tax credits no longer be available, but battery costs fall to ~\$900/KWh, PHEVs would make sense when gas is above \$4.84 per gallon. These price levels already exist in countries with high gasoline taxes.

Exhibit 29: Scenario 3

	Gasoline	Diesel	HEV	PHEV	EV
Base Car Price	\$ 18,500	\$ 19,500	\$ 20,500	\$ 22,000	\$ 18,000
Battery Costs	\$ -	\$ -	\$ 1,080	\$ 9,000	\$ 18,000
Tax Credit	\$ -	\$ -	\$ -	\$ -	\$ -
Purchase Costs	\$ 18,500	\$ 19,500	\$ 21,580	\$ 31,000	\$ 36,000
Annual Fuel Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 150	\$ -
Annual Electricity Costs	\$ -	\$ -	\$ -	\$ 426	\$ 532
Annual Maintenance	\$ 607	\$ 607	\$ 637	\$ 668	\$ 425
Annual Variable Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 576	\$ 532
Total Discounted cost	\$ 29,906	\$ 27,504	\$ 29,691	\$ 35,669	\$ 40,315
Cost per Mile	\$ 0.199	\$ 0.183	\$ 0.198	\$ 0.238	\$ 0.269
Breakeven Points					
Min Gas Price (vs. Gasoline ICE)			\$3.03/gal	\$4.84/gal	\$5.35/gal
Min Diesel Price (vs. Diesel ICE)			\$4.67/gal	\$5.52/gal	\$6.04/gal



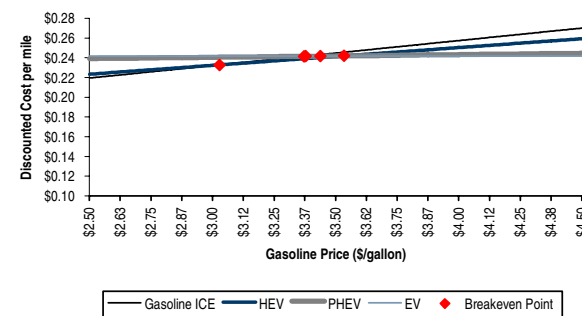
Source: Credit Suisse estimates

Scenario 4: Battery costs fall to near-term target, tax credits remain

If we assume battery costs fall to our near-term target of \$900/KWh, and that the generous credit remains in place, PHEVs make sense when gasoline is above \$3.37 per gallon and EVs make sense when gas is above \$3.38 gallon.

Exhibit 30: Scenario 4

	Gasoline	Diesel	HEV	PHEV	EV
Base Car Price	\$ 18,500	\$ 19,500	\$ 20,500	\$ 22,000	\$ 18,000
Battery Costs	\$ -	\$ -	\$ 1,080	\$ 9,000	\$ 18,000
Tax Credit	\$ -	\$ -	\$ -	\$ 5,000	\$ 7,500
Purchase Costs	\$ 18,500	\$ 19,500	\$ 21,580	\$ 26,000	\$ 28,500
Annual Fuel Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 150	\$ -
Annual Electricity Costs	\$ -	\$ -	\$ -	\$ 426	\$ 532
Annual Maintenance	\$ 607	\$ 607	\$ 637	\$ 668	\$ 425
Annual Variable Costs	\$ 1,406	\$ 987	\$ 1,000	\$ 576	\$ 532
Total Discounted cost	\$ 29,906	\$ 27,504	\$ 29,691	\$ 30,669	\$ 32,815
Cost per Mile	\$ 0.199	\$ 0.183	\$ 0.198	\$ 0.204	\$ 0.219
Breakeven Points					
Min Gas Price (vs. Gasoline ICE)			\$3.03/gal	\$3.37/gal	\$3.38/gal
Min Diesel Price (vs. Diesel ICE)			\$4.67/gal	\$3.74/gal	\$3.70/gal



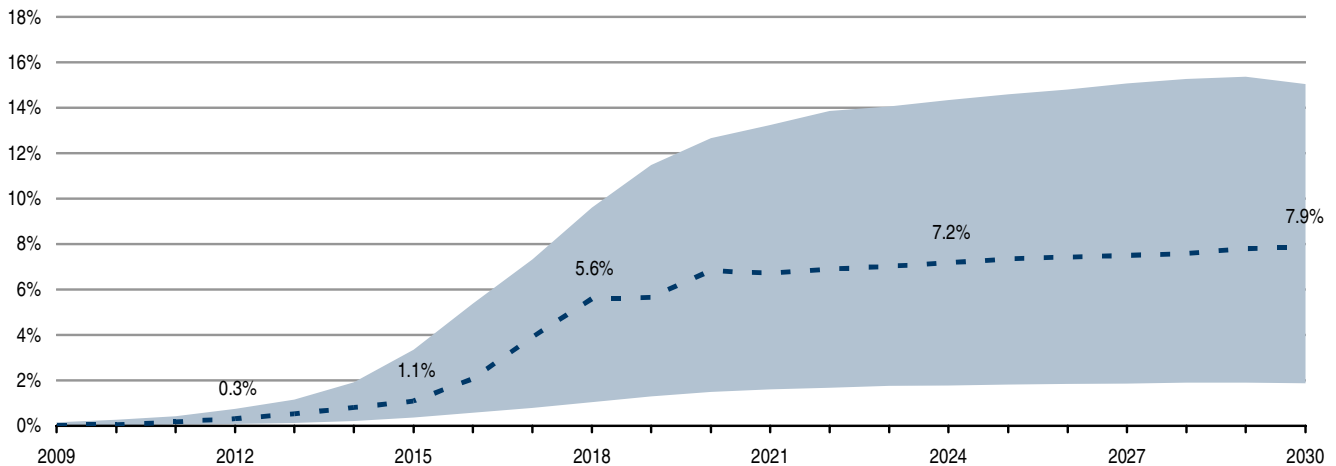
Source: Credit Suisse estimates

Potential Adoption Rates

While we do not attempt to forecast specific HEV, PHEV, and EV sales by manufacturer, we do provide a framework that presents a hypothetical scenario for adoption rates. There are far too many moving parts to arrive at a specific forecast, as gas prices, fuel taxes, biofuel technologies, battery costs, consumer preferences, government subsidies, and policy mandates all impact adoption rates. That said, our model forecasts a potential adoption rate for PHEVs and EVs based on an economic framework.

Figure 31: PHEV and EV Penetration Rate

Global penetration rate of both Electric Vehicles and Plug-in Electric Vehicles

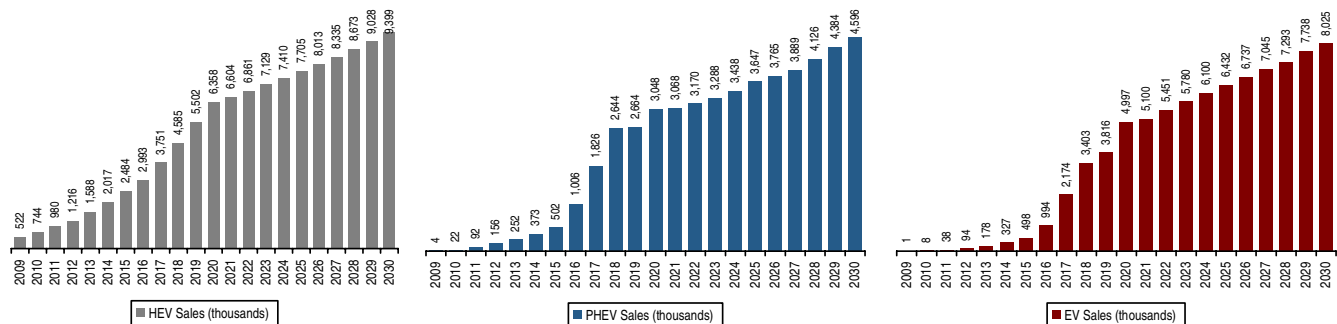


Source: Credit Suisse estimates

Plug-in hybrid electric vehicle and pure electric vehicle sales are calculated using the relative total discounted cost to estimate a warranted penetration rate. The ratio is calculated by taking the total costs of driving an electric vehicle compared to an internal combustion gasoline vehicle. The cost of electric vehicles declines over time, using our forecasts for battery prices, subsidies, gas prices and taxes within each country. The warranted penetration rate is a function of rational decisions along with a small percent of consumers who purchase the vehicle due to concerns over the environment or other non-economic factors. You may argue that if electric vehicles are truly economic, everyone (or at least a majority) would purchase them instead of regular vehicles. We present a scenario where there is a 1.50% penetration rate when PHEVs and EVs are economic, which gradually increases, reaching ~12% when the total costs are more than 20% lower than operating an internal combustion engine vehicle.

Exhibit 32: HEV, PHEV, and EV Potential

Assumptions are based on our multivariate model and include government incentives, gas prices, and adoption curves

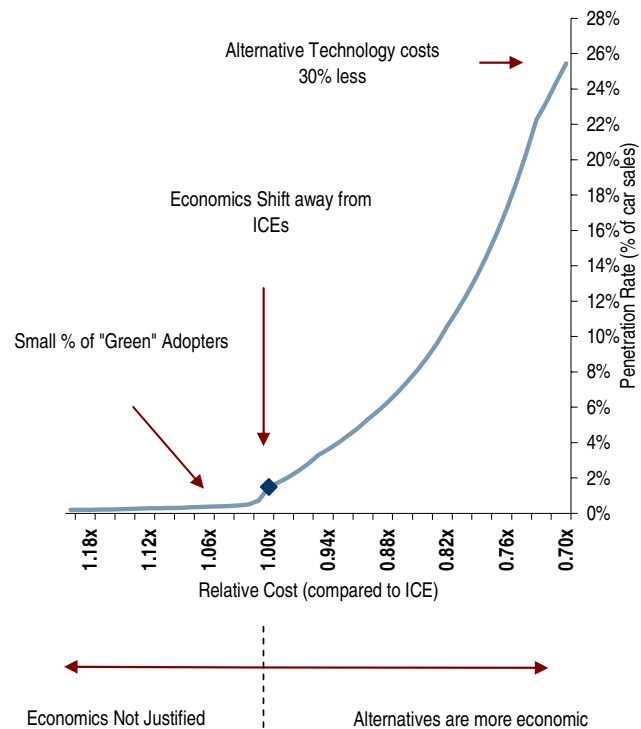


Source: Credit Suisse estimates

Exhibit 33: Warranted Penetration rates for PHEV and EVs

Relative Cost is the Ratio of the total discounted costs for a PHEV or EV divided by the cost of a Gasoline ICE Vehicle

	Relative Cost		Rational Decisions		Green Factor		Penetration
Economic	0.60x	:	38.19%	+	2.00%	=	40.19%
	0.70x	:	23.45%	+	2.00%	=	25.45%
	0.80x	:	10.39%	+	2.00%	=	12.39%
	0.90x	:	4.01%	+	1.30%	=	5.30%
	0.91x	:	3.64%	+	1.18%	=	4.82%
	0.92x	:	3.31%	+	1.07%	=	4.38%
	0.93x	:	3.01%	+	0.97%	=	3.99%
	0.94x	:	2.74%	+	0.89%	=	3.62%
	0.95x	:	2.49%	+	0.81%	=	3.29%
	0.96x	:	2.07%	+	0.73%	=	2.81%
	0.97x	:	1.73%	+	0.67%	=	2.39%
Not Economic	0.98x	:	1.44%	+	0.61%	=	2.05%
	0.99x	:	1.20%	+	0.55%	=	1.75%
	1.00x	:	1.00%	+	0.50%	=	1.50%
	1.01x	:	0.25%	+	0.48%	=	0.73%
	1.02x	:	0.06%	+	0.45%	=	0.51%
	1.03x	:	0.02%	+	0.43%	=	0.44%
	1.04x	:	0.00%	+	0.41%	=	0.41%
	1.05x	:	0.00%	+	0.39%	=	0.39%
	1.06x	:	0.00%	+	0.37%	=	0.37%
	1.07x	:	0.00%	+	0.35%	=	0.35%
	1.08x	:	0.00%	+	0.33%	=	0.33%
	1.09x	:	0.00%	+	0.32%	=	0.32%
	1.10x	:	0.00%	+	0.30%	=	0.30%
	1.11x	:	0.00%	+	0.28%	=	0.28%
	1.12x	:	0.00%	+	0.27%	=	0.27%
	1.13x	:	0.00%	+	0.26%	=	0.26%
	1.14x	:	0.00%	+	0.24%	=	0.24%
	1.15x	:	0.00%	+	0.23%	=	0.23%



Source: Credit Suisse estimates

Top down, we have estimates for future oil prices (impacting gasoline prices) and battery costs. We are using \$60/barrel oil for 2010, \$70 in 2011 and 2012 (consistent with our Global Oil team's view), \$80 in 2020, and \$90 in 2030. This results in an ex-tax gasoline price of \$2.15 per gallon in 2010, increasing to \$2.66 in 2030. Additionally, each country has a set fuel tax (\$0.40 in the US, \$2.41 in Japan, \$4.19 in the UK, \$1.06 in Canada, etc). This tax, which we assume to be fixed per gallon, will likely be modified over time and could potentially shift to other taxation methodologies.

Each vehicle type has a base cost, which is estimated from models already being sold along with commentary from industry experts. PHEVs cost \$22,000 (excluding the battery) while a traditional internal combustion sedan is \$18,500. Battery costs are estimated to cost \$1,200 per KWh today, declining to \$900/KWh by 2012, and \$500/KWh by 2020. The size of the battery within a PHEV is estimated to be 10 KWh, while EVs are 20 KWh. HEVs, such as the Toyota Prius, only use ~1.2 KWh batteries. These do not match with the exact vehicle models that are planned (for example the Chevy Volt – a PHEV – will have a 16 KWh battery while Mitsubishi's iMIEV pure EV will also have a 16 KWh battery). There are also subsidies for HEVs, PHEVs, and EVs that are either limited by the total number of vehicles or expire between 2015 and 2025.

Exhibit 34: Country Incentives and Car Sales

Country	Average Vehicle Sales	Fuel Tax (\$/gal)	Electricity (\$/KWh)	HEV Incentive	PHEV/EV Incentive	kgCO2 per kWh electricity consumed
United States	16,174	\$0.401	\$0.106	\$2,000	\$5,000	0.600 kg
China	7,911	\$0.361	\$0.071	\$0	\$8,800	0.843 kg
Japan	5,534	\$2.413	\$0.178	\$2,000	\$2,900	0.439 kg
Germany	3,568	\$4.564	\$0.222	\$0	\$970	0.431 kg
France	2,552	\$4.275	\$0.158	\$0	\$4,448	0.091 kg
UK	2,715	\$4.194	\$0.219	\$0	\$8,220	0.543 kg
Italy	2,568	\$4.101	\$0.258	\$0	\$4,170	0.427 kg
India	1,799	\$2.439	\$0.047	\$0	\$0	1.289 kg
Canada	1,675	\$1.058	\$0.076	\$0	\$7,000	0.200 kg
Spain	1,807	\$2.892	\$0.165	\$0	\$6,950	0.388 kg
Australia	1,010	\$1.077	\$0.098	\$0	\$0	0.997 kg
Denmark	215	\$4.148	\$0.322	\$0	\$10,000	0.388 kg
Rest of World	21,613	\$0.150	\$0.142	\$0	\$0	0.591 kg
Total	69,140	\$1.279		\$628	\$3,483	

Sources: Polk, Country Websites, DEFRA (UK), IEA Gasoline Pricing Survey (June 2009), many figures estimated or derived from other data

Notes: US Incentive depends on battery size. For our analysis, a PHEV contains a 10 KWh batter, resulting in a \$5,000 subsidy while pure Electric Vehicles are eligible for the full \$7,500

All cash flows associated with the investment (electricity bills, maintenance, fuel, etc) are discounted by 4%, which clearly does not represent a financing cost but rather time value money for the outlay with a guaranteed utility to the consumer (ie, risk free).

Electricity costs are estimated using the current average residential rate. We do realize that over time consumers will likely be switched to time-of-use rates (providing less expensive power during off-peak times) or will have smart charging systems due to advanced metering infrastructure. We therefore assume that gradually consumers will be able to benefit from reduced rates (5% discount by 2010, 10% in 2012, and 25% by 2015). In California, for example, a consumer can be eligible for discounted rates if they are charging an electric vehicle. Other areas (in the US and elsewhere) often provide multiple tiers of rates, especially for commercial customers.

All of these factors result in a net present value of each vehicle type, which determines how economic each alternative is. This gets passed into the model and determines the penetration rate that is warranted. There is also a production capacity limitation, particularly important in the early years. In 2009 we assume only 5,000 PHEVs or EVs can be produced, 30,000 in 2010, a staggering 130,000 by 2011, 250,000 in 2012, 430,000 in 2013, and 1 million by 2015. The production restraint is the main limiting factor in early years. Arriving at these estimates is not precise as it really depends on what auto manufacturers decide to produce and how quickly battery companies bring capacity online. GM has said that they will have production capacity of 60,000 vehicles per year, but that number may be low in the early years. The same issue is true for Nissan's LEAF and Mitsubishi's iMiEV. Renault and Better Place announced a capacity target of 100,000 per year by 2016.

Figure 35: Large Format Lithium Ion Battery Production Constraints

	2009	2010	2011	2012	2013	2014	2015	...
LiB Production Capacity	5,000	30,000	130,000	250,000	430,000	700,000	1,000,000	unl.

Source: Credit Suisse estimates

We assume the penetration rate of HEVs using a more simplistic model. As there is less technology risk and the economics do not shift radically with changes in battery or gas prices, we grow the penetration rate on a country by country basis. In 2008, the largest markets were the United States (2.1% penetration), Japan (1.5%), Canada (1.1%), and the UK (0.6%). Other major countries that currently do not have hybrid sales will experience gradual adoption, but at a slower pace. Note that we do not assume any adoption in countries not listed below. By 2030 we have HEV penetration in the low teens

in most industrialized countries, while others are in the single digits. The interactive model allows you to change how HEVs are forecasted. Given the track record of HEV sales, we felt that it is prudent to modify historic adoption rates instead of using an economically warranted penetration rate.

Exhibit 36: Key Assumptions for HEV Adoption by Country

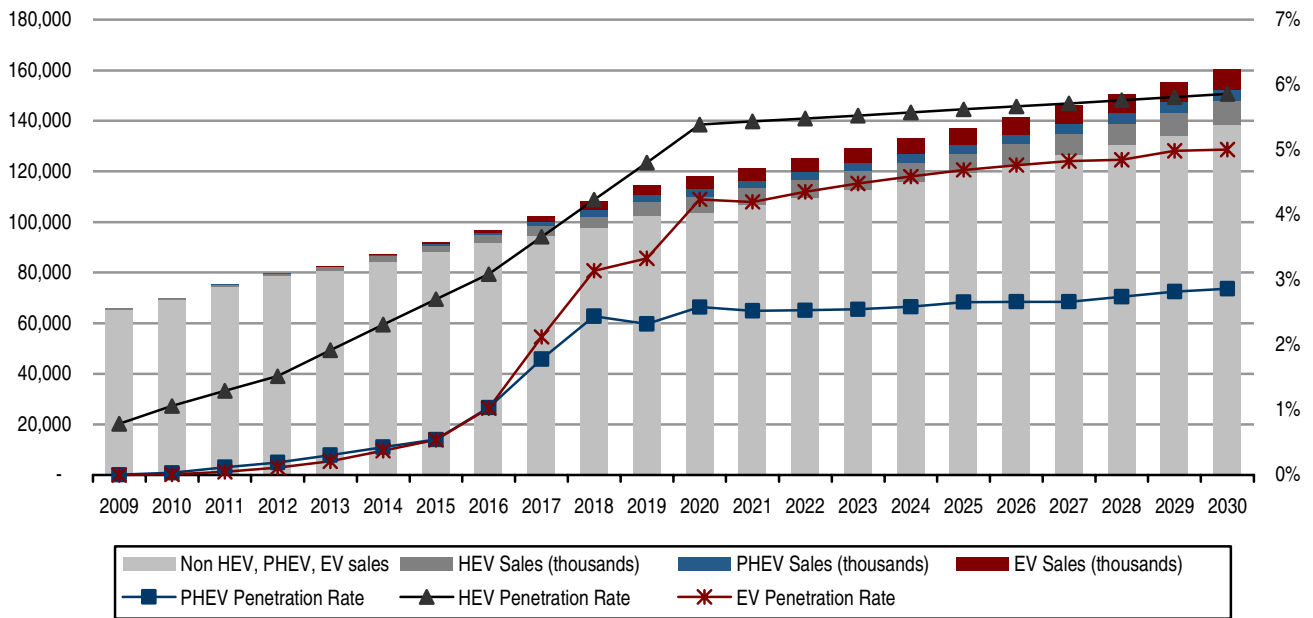
Country	2008 HEV Penetration	Change in penetration rates (per year)				2030 HEV Penetration
		2009-2012	2013-2016	2017-2020	2021-2030	
United States	2.1%	0.40%	0.80%	1.20%	0.10%	12.7%
China	0.0%	0.20%	0.60%	1.00%	0.10%	8.2%
Japan	1.5%	1.00%	1.00%	1.20%	0.10%	15.3%
Germany	0.0%	0.20%	0.40%	0.20%	0.10%	4.2%
France	0.0%	0.40%	0.80%	1.20%	0.10%	10.6%
UK	0.6%	0.40%	0.80%	1.20%	0.10%	11.2%
Italy	0.0%	0.10%	0.10%	0.30%	0.10%	3.0%
India	0.0%	0.10%	0.20%	0.10%	0.10%	2.6%
Canada	1.1%	0.50%	0.80%	1.20%	0.10%	12.1%
Spain	0.0%	0.05%	0.10%	0.50%	0.10%	3.6%
Australia	0.0%	0.10%	0.10%	0.10%	0.10%	2.2%
Denmark	0.0%	0.20%	0.50%	1.00%	0.10%	7.8%
Rest of World	0.0%	0.00%	0.00%	0.00%	0.00%	0.0%
2008		2009	2015	2020	2025	2030
% HEVs Using Li (vs. NiMH)		1%	27%	62%	72%	82.0%

Source: Credit Suisse estimates

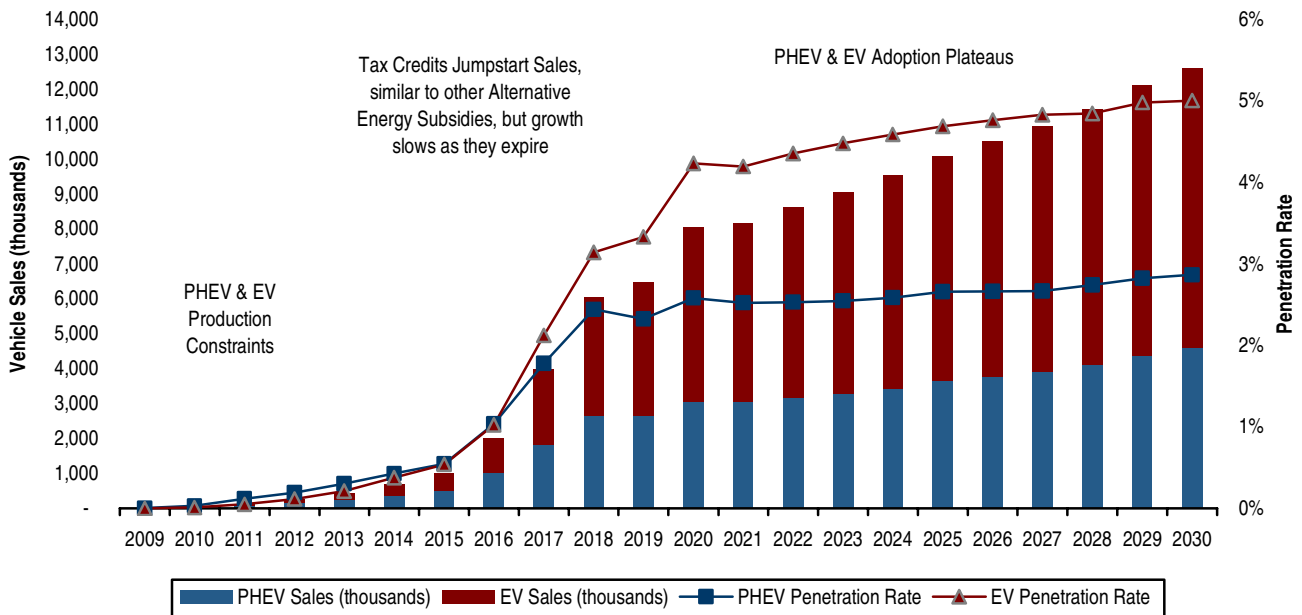
Exhibit 37: Forecast for 2030

Country	HEVs			PHEVs			EVs		
	2030 Penetration	2030 Sales (k)	Total HEV Sales (k)	2030 Penetration	2030 Sales (k)	Total PHEV Sales (k)	2030 Penetration	2030 Sales (k)	Total EV Sales (k)
United States	12.7%	3,437	44,858	0.4%	121	1,380	1.8%	475	4,340
China	8.2%	3,160	31,584	0.7%	279	2,956	2.8%	1,081	9,218
Japan	15.3%	775	12,464	4.8%	244	3,147	7.4%	377	4,499
Germany	4.2%	210	2,620	12.4%	619	7,546	18.7%	936	10,946
France	10.6%	315	4,277	14.6%	433	5,373	22.3%	661	8,286
UK	11.2%	484	5,957	10.6%	459	5,450	15.8%	687	7,802
Italy	3.0%	108	1,139	8.8%	318	3,685	12.4%	445	5,163
India	2.6%	383	3,051	9.6%	1,419	12,336	15.8%	2,332	20,594
Canada	12.1%	256	3,524	3.3%	70	751	5.3%	112	1,284
Spain	3.6%	217	1,799	6.8%	412	4,689	10.6%	639	6,784
Australia	2.2%	24	266	2.8%	30	301	4.8%	52	552
Denmark	7.8%	32	360	6.8%	28	576	8.8%	36	690
Rest of World	0.0%	0	0	0.3%	164	1,770	0.4%	192	2,073
Total	5.9%	9,399	111,897	2.9%	4,596	49,959	5.0%	8,025	82,230

Source: Credit Suisse estimates

Exhibit 38: Summary of Forecast: HEVs, PHEVs, and EVs still represent a small portion of vehicle sales

Source: Credit Suisse estimates

Exhibit 39: PHEV & EV Penetration

Source: Credit Suisse estimates

Exhibit 40: Key Model Assumptions

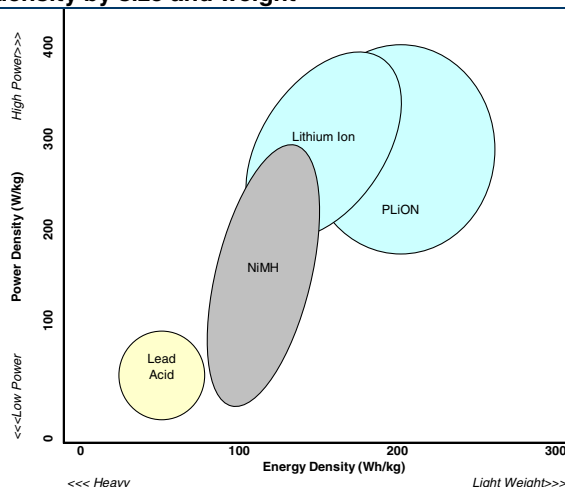
Base Car Price (excludes battery)		Vehicle Comparisons	
Gasoline ICE	\$ 18,500	Gas ICE	32 mpg
Diesel	\$ 19,500	Diesel ICE	38 mpg
HEV	\$ 20,500 (\$21,940 with battery)	HEV	45 mpg
PHEV	\$ 22,000 (\$34,000 with battery)	PHEV (with ICE)	60 mpg
EV	\$ 18,000 (\$42,000 with battery)	PHEV Gas ratio	20%
Discount Rate	4.0%	* Note: PHEV gas ratio is the percent of miles driven on gasoline (vis-à-vis charge sustaining mode or Parallel hybrid)	
Vehicle Use Assumptions		Annual Maintenance Expense, average	
Annual mileage	15,000 miles	Gasoline ICE	\$607 * Edmunds estimates, averaged over 5 years
Life of Vehicle	10 yrs	HEV	\$637
		PHEV	\$668
		EV	\$425
Fuel Costs			
	Current		
Gasoline Price	\$3.00/gal		
Diesel Price	\$2.50/gal		
	2009	2010	2011
Oil (WTI)	\$66/bbl	\$60/bbl	\$70/bbl
Gasoline Price, ex-tax	\$2.25/gal	\$2.15/gal	\$2.32/gal
	2012	2015	2020
	\$2.32/gal	\$2.41/gal	\$2.49/gal
	2030+		
	\$2.66/gal		
* Note: gas prices increase with oil price, assuming half of 2009 cost is non-oil related, per EIA estimate			
Battery Assumptions			
	2009	2012	2020
	Current	Mid-term	Long-term
Battery Price (\$/kWh)	\$1,200/KWh	\$900/KWh	\$500/KWh
* Note: Battery price includes warranty for battery for life of vehicle			
	Size	LiCO3	Cost of Lithium
HEV Battery Size	1.2 KWh	0.60 kg/KWh	0.7 kg/battery \$ 4.76
PHEV Battery Size	10.0 KWh	0.60 kg/KWh	6.0 kg/battery \$ 39.68
EV Battery Size	20.0 KWh	0.60 kg/KWh	12.0 kg/battery \$ 79.37
Electricity Price	\$0.106/KWh	* Note: Electricity Price varies by country, this assumption applies to just US	
Battery mileage	3 mi/KWh		
Current LiCO3 Price	\$6.61/kg	(\$3/lb)	
HEV Adoption Forecasts			
% HEVs Using Li (vs. NiMH)	0.0%	1%	27%
			62%
			72%
			82.0%
PHEV & EV Manufacturing Constraints			
	2009	2010	2011
LiB Production Capacity	5,000	30,000	130,000
			250,000
			430,000
			700,000
			1,000,000
			unl.
* Note: PHEV and EV LiB production capacity is constrained in the early years, which limits adoption.			
Energy Assumptions			
	2009	2010	2011
Smart Charging Discount	0%	5%	5%
			10%
			15%
			20%
			25%
			25%
* Note: The smart charging discount is the discount off of the average retail electricity rate, which will represent the off-peak charging or rates that are subsidized due to smart charging (quasi-storage) for grid regulation (or reliability)			
Natural Gas Heat Rate (mmBTU/MWh)		7.196	
Natural Gas Electric Generation (on margin)		100%	
CO2 per Gallon of Gasoline		8.8 kg/gal	
Gallons Gasoline per Barrel of Oil		42 gallons	
* Note: While only ~19 gallons of gasoline is produced from each barrel of oil, you cannot change production			

Source: Credit Suisse estimates

Batteries Are Key

Auto manufacturers are facing big challenges finding suitable storage solutions for electric vehicles. The batteries should be inexpensive, small, light, safe, have a high power and energy density and last at least 10 years without substantial degradation. Batteries are the critical component and are currently the limiting factor – both from a cost and technical perspective. The most important characteristic of the battery, beyond the cost, is the energy density. The energy density is the amount of energy that can be stored, divided by the weight. Batteries in electric vehicles can weigh upwards of 400 pounds.

Exhibit 41: Energy density by size and weight



Source: Credit Suisse Research

Exhibit 42: Summary of Battery Technologies

	Nickel-Cadmium NiCd	Nickel-metal hydride NiMH	Nickel Zinc NiZn	Lead-acid (sealed) PbA	Zebra NaNiCl	Lithium-ion cobalt	Lithium-ion manganese	Lithium-ion phosphate
Energy Density	45-80	60-120	60	30-50	90-120	150-190	100-135	90-120
Cycle Life	1500	300 to 500	200-500	200 to 300	1000	300-500	300-600	>1000
Fast Charge Time	1 hr	2 to 4 hrs	1 hr	8 to 16 hrs	1 hr	1.5 to 3 hrs	<1 hr	<1 hr
Overcharge Tolerance	moderate	low	na	high	na	low	low	low
Self-discharge / Month (room temp)	20%	30%	20%	5%	zero	<10%	<10%	<10%
Cell Voltage (normal)	1.25V	1.25V	1.7V	2V	2.58V	3.7V	3.8V	3.3V
Best Load Current (peak)	1C (20C)	0.5C (5C)	na	0.2C (5C)	na	<1C (<3C)	10C (>30C)	10C (>30C)
Operating Temperature (°C)	-40 to 60	-20 to 60	-20 to 60	-20 to 60	270 to 350	-20 to 60	-20 to 60	-20 to 60
Maintenance Requirements	30-60 days	60-90 days	na	3-6 months	maintenance free	na	na	na
Commercial Introduction	1950	1990	na	1970	1982	1991	1996	2006
Suitability for Vehicle Applications	poor	Adequate for HEV	Adequate for HEV	poor	EV, HEV, & PHEV	poor	EV, HEV, & PHEV	EV, HEV, & PHEV
Costs \$/kWh	~410	~600	~300			>1000	>1000	>1000
Safety Issues	Thermally stable	Thermally stable	Thermally stable	Thermally Stable	High operating temperature 270°C - 350°C	Protection circuit required, stable to 150°C	Protection circuit recommended, stable to 250°C	Protection circuit recommended, stable to 250°C
Strengths	-Long life cycle -Safety	-High power -Safety -Compact	-Safety -Relatively inexpensive	-Inexpensive -Recyclable -Mature technology -High power	-High power -Long life cycle	-Compact	-Compact	-Compact
Weaknesses	-Toxic materials -Maintenance -Cost -Moderately compact	-Cost -Life cycle -Generates high heat	-Low life cycle -Moderately compact	-Not compact	-High temperature	-Safety issues -Cost -Calendar life	-Safety issues -Cost -Calendar life	-Safety issues -Cost -Calendar life
Battery Manufacturers	Sanyo, Panasonic, Saft, Eagle-Picher	Sanyo, 3M, PEVE, Panasonic, Saft, COBASYS, A123	Powergenix, SCPS Group, Kellierion		mes-dea	3M, E-One Moli Energy, Sony, Panasonic, Sanyo	Ener1, Compact Power (LG Chem), 3M, Johnson Controls-Saft, Sony	A123, Valence, GS Yuasa, BYD
Auto Manufacturers		BMW, Chery, Chrysler, Daimler, Ford, GM, Honda, Porsche, Toyota, Volkswagen			Thlink, Modec		Chevrolet, Thlink, Ford	BYD

Source: Advanced Automotive Batteries, E3BV, Battery University, Company data, Credit Suisse estimates

To date, the mass produced HEV cars have been powered by nickel metal-hydride (NiMH) batteries, which are larger and heavier than lithium ion. The battery in a Prius, for example, puts a premium on power over energy, as the battery is frequently charged and

discharged but does not need to go for long distances, as it is a supplement to the internal combustion engine (ICE). The exhibit below shows an increased power performance development of the battery packs with stabilized energy capacity. Note that there is no significant difference in the major characteristics between the 2004 and 2010 Prius battery, as NiMH is a rather mature technology and the 2004 pack was performing very well. There were a few improvements made to the 2010 model that are not depicted in the table below, as they related to thermal management (cooling fans) and packaging materials.

Exhibit 43: Prius Battery Packs

	1997 Prius	2000 Prius	2004 Prius	2010 Prius
Chemistry	NiMH	NiMH	NiMH	NiMH
Form Factor	Cylindrical	Prismatic	Prismatic	Prismatic
Cells (Modules)	240 (40)	228 (38)	168 (28)	168 (28)
Nominal Voltage	288.0 V	273.6 V	201.6 V	201.6 V
Nominal Capacity	6.0Ah	6.5Ah	6.5Ah	6.5Ah
Specific Power	800 W/kg	1000 W/kg	1300 W/kg	1300 W/kg
Specific Energy	40 Wh/kg	46 Wh/kg	46 Wh/kg	46 Wh/kg
Module Weight	1090g	1050g	1040g	1040g
Module Dimensions	35(oc)x384(L)	19.6x106x275	19.6x106x285	19.6x106x285

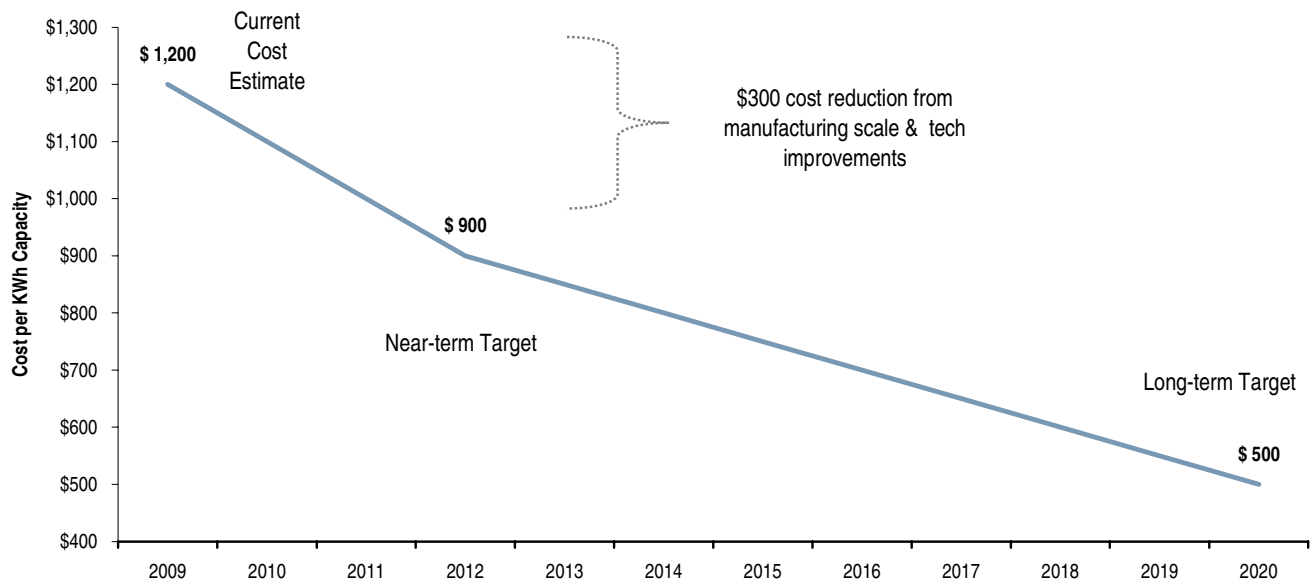
Source: 1997, 2000, and 2004 Specifications from Toyota Prius Battery website, 2010 model from Company Data and Credit Suisse estimates

Lithium Ion Battery Pack Costs

There is a lot of uncertainty and speculation about the prices of lithium ion batteries. The different chemicals, raw material and assembling qualities, low production capacities and battery sizes make it difficult to accurately estimate costs. In addition to these uncertainties, governments provide substantial support to the battery manufacturers for the development and production of battery packs.

We estimate today's costs for lithium battery packs between \$1,200 and ~\$1,600 per kWh, assuming very low margins: \$800-\$1,000 for the cells & \$400-\$600 for the module (assembly, controllers, connectors, and electronics). That said, the costs have come down rapidly. For our analysis, we assume total costs are \$1,200 per kWh in 2009, decreasing to \$900 in 2012 and eventually reaching \$500 by 2020. We believe the cost reductions are feasible given economies of scale.

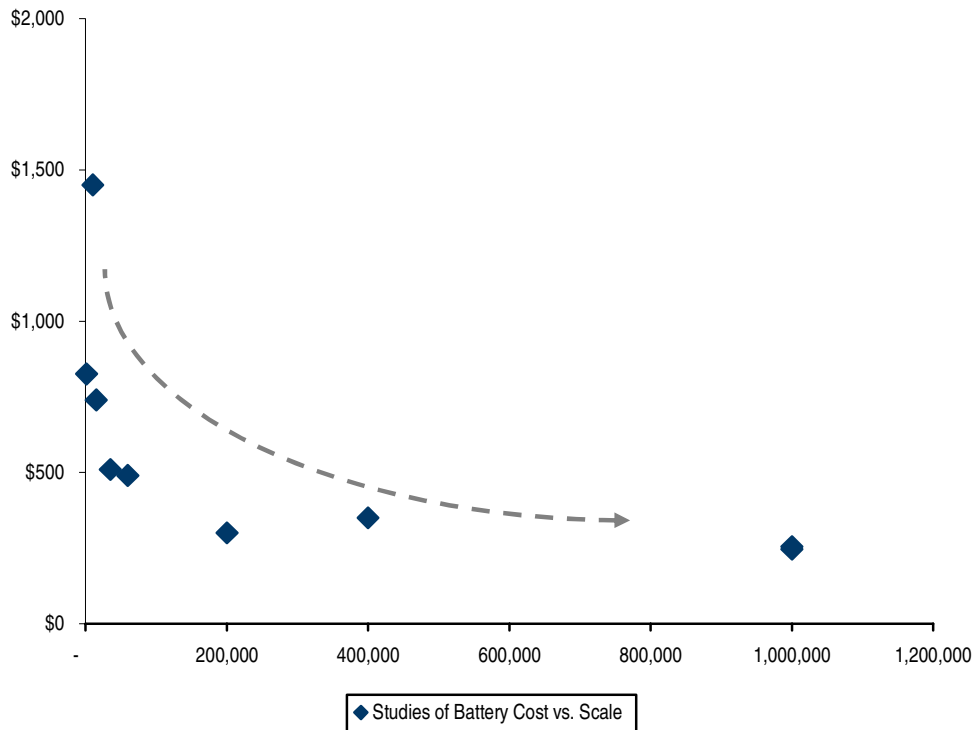
Exhibit 44: Lithium Ion Battery Cost Estimates & Forecasts



Source: Company data, Credit Suisse estimates

Industry experts have corroborated these estimates, noting that there is significant uncertainty and a very large range is needed. An “all-in” range of \$1,000 to \$1,500 per kWh of capacity for PHEV applications (roughly 10-16 kWh) seems to be an accepted range within the industry, but industry participants are hesitant to provide detailed breakdowns of the current cost structure. Independent studies have indicated a bottoms-up cost estimate of nearly \$1,500 to \$250 per kWh, which is highly dependent on the manufacturing scale.

Figure 45: Lithium Ion Battery Cost Estimates from Other Studies show Substantial Economies of Scale



Source: Credit Suisse Estimates, Summary of Studies by German Aerospace Center (DLR) Institute of Vehicle Concepts

Safety concerns

Consumers worry about the safety issues resulting from lithium battery use. Fires involving Sony laptop batteries have stuck in people's minds. If a small laptop battery can make a laptop burn or even explode, what can a 400+ pound battery do to the passengers in a car? Cell phones, laptops and digital cameras use cobalt chemistry to achieve higher runtime. This chemistry gets thermally unstable when the cells reach 150°C and this condition can lead to a thermal runaway in which flaming gases are vented. Unlike cobalt based batteries, phosphate and manganese based batteries, which will be used for electric vehicles, will remain stable until 250°C. In a Wall Street Journal interview, Mr. Wang, CEO of BYD, says their lithium-ion battery uses an iron-phosphate technology that is chemically stable and thus "inherently safe." He says it doesn't overheat to the point where it can catch fire.

Additionally, there is concern over batteries being punctured or accessed inappropriately, leading to electrocution. Safety systems have been engineered so the voltage contained in the system will dissipate upon system breach or failure. The batteries are placed inside a protective case, reducing any risk.

In our opinion the safety concerns have largely been overblown. After all, gasoline is a highly flammable substance as well. Hydrogen gas is much more dangerous, as it is under immense pressure and can ignite extremely easily. We believe that the lithium ion technologies that win will win partly on their safety argument, possibly sacrificing some energy density.

Battery life time

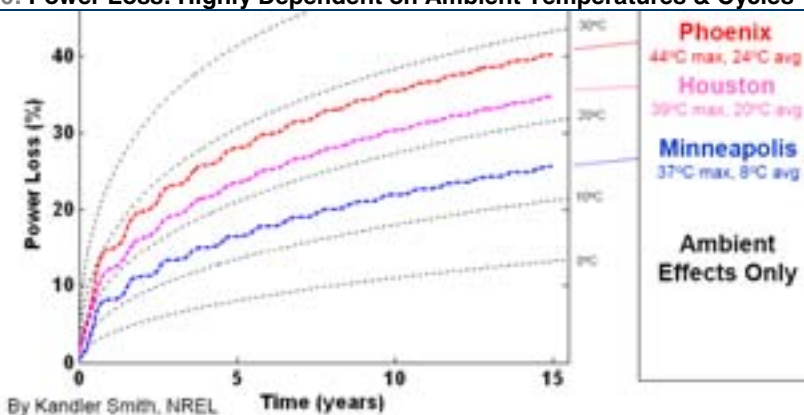
We all remember when the laptop battery life of laptops decreased within 2 years from one hour to 5 minutes. This is certainly a scenario future electric vehicle buyers are still concerned about. Knowing about these concerns and optimistic about their battery pack,

Toyota provides a 100,000 mile or 8 year battery warranty to Prius customers. In addition HEVs can also function with lower capacity as the Prius uses the battery mainly as power levelling function and not as capacity.

The life cycle of the lithium batteries are highly dependent on the chemistry. BYD's Lithium Ion Phosphate battery packs should last at least 5 years until the capacity is reduced to 80%. The LG battery packs for the Chevrolet Volt initially only uses 50% of its capacity. That means the battery, at most, gets discharged to 30% and recharged to 80% of its capacity. This extends the durability of the storage system to up to 10 years without significant loss of capacity, or at least that is what is expected. The lifetime of lithium ion batteries has yet to be proven, resulting in substantial uncertainty and risks for those who will have to provide a warranty.

Thermal management is also very important for battery safety and longevity. Auto manufacturers are testing both liquid and air cooled systems. The issue is that the storage temperature of the battery (ie, when you are parked) significantly impacts performance and duration. Some experts argue that this is the single largest obstacle. The thermal management systems attempt to maintain a low temperature, even when the vehicle is not in operation. Nissan, for example, is conducting on-road tests in Phoenix, Arizona to make sure the LEAF's battery can perform adequately in warm climates. After all, auto manufacturers will have to provide a warranty for the battery.

Figure 46: Power Loss: Highly Dependent on Ambient Temperatures & Cycles

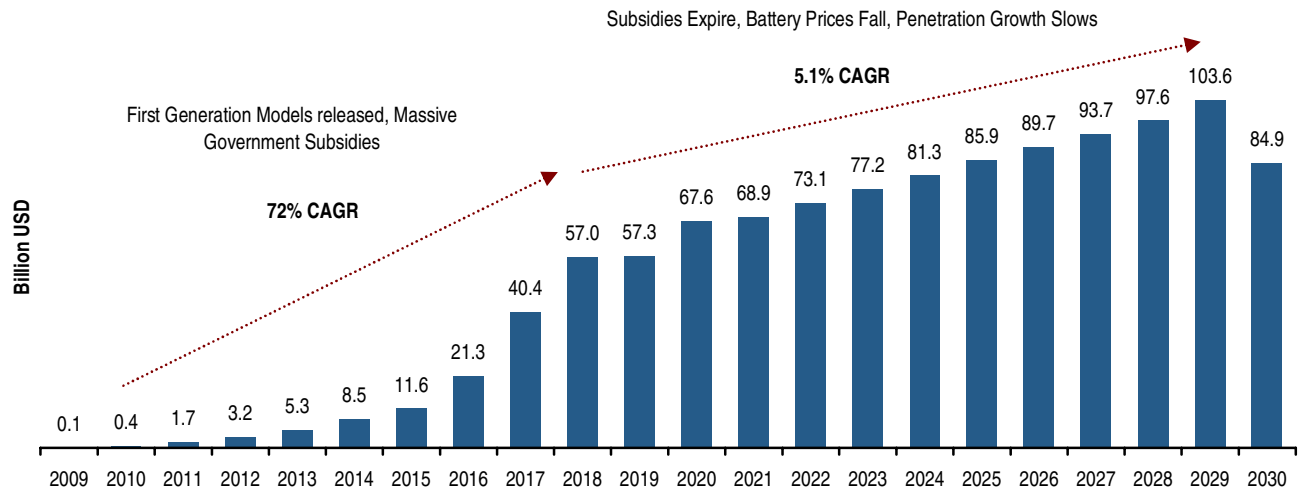


Source: National Renewable Energy Laboratory (NREL)

Battery Market Size

Given the massive growth opportunity and high cost of Lithium Ion batteries, we expect the market size for large-scale lithium ion batteries to grow substantially, potentially reaching \$100 billion within 20 years. Volumes will grow faster than the market size as prices come decline with costs.

Exhibit 47: Large Format Lithium Ion Battery Market Size: Potentially Reaching \$100+ billion within 20 years



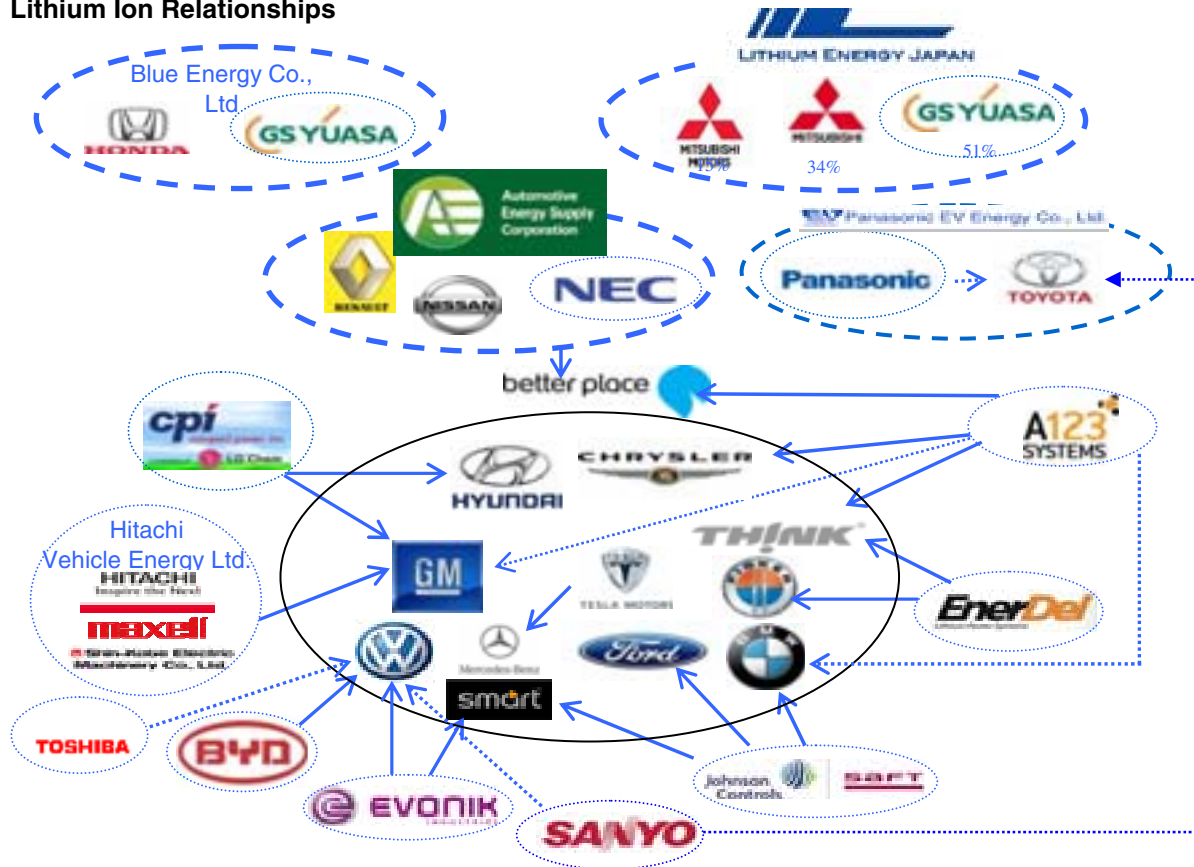
Source: Credit Suisse estimates

Battery Supplier Relationships

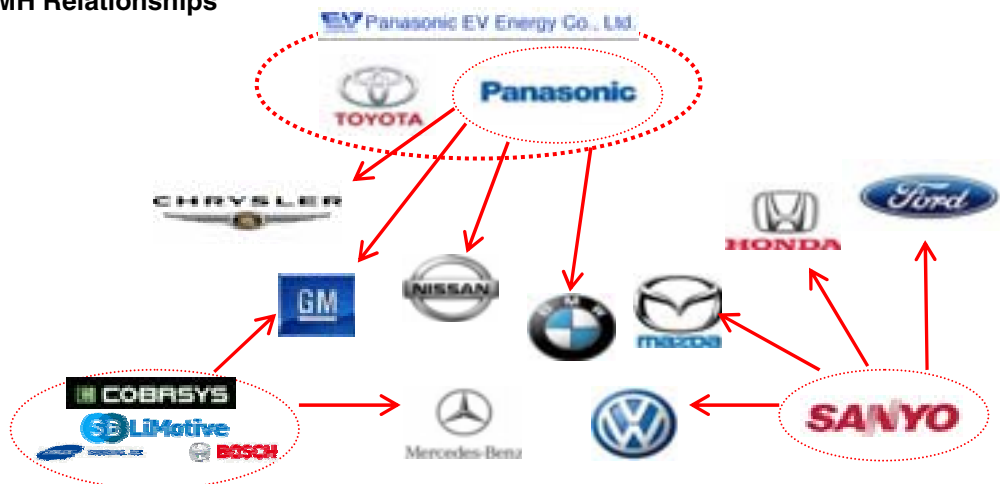
There are a litany of joint ventures and partnerships for NiMH and Li Ion batteries. At this stage, when automotive manufacturers are just starting to develop electric vehicles, the partnership with a battery supplier is very important. It is worth noting that several auto companies have preferred joint ventures, which may pressure battery companies' margins. We believe those that remain autonomous have a higher likelihood of retaining intellectual property and faring better should large-scale lithium batteries become a commodity.

Exhibit 48: Battery Partnerships

Lithium Ion Relationships



NiMH Relationships



Source: Credit Suisse Research, Company data.

Connecting to the Grid

Charging Infrastructure

Charging stations will be a necessity to plug in and charge vehicles as cars, like people, do not always return home each evening. Mass adoption will likely only be feasible once consumers feel comfortable knowing they can fuel their vehicles away from home. The dilemma is which comes first, the electric vehicles or the charging infrastructure.

Currently some cities are collaborating with companies and institutions to prepare for the market penetration of electrified vehicles. ChargePoint by Coulomb Technologies offers a subscription based model to provide public charging infrastructure. Another company, eTec (a division of ECOtality, ETLY, not rated) has received nearly \$100 million in grant funds to install approximately 12,750 charging stations along west coast and eastern states to complement Nissan's targeted launch of their LEAF electric vehicle.

The plug-in charging stations, which look a lot like standard parking meters, have the purpose of charging the batteries. The electric recharging points can and will be found mainly on the road, parking lots and taxi stands. More than half of all homeowners in the U.S. have access to a plug to charge their vehicle over night. The main problem, we believe, will be the technical issue of quick charging the batteries which we believe could be installed at gas station locations. To charge a 16kWh battery pack in 10 minutes from 10% to 80%, it requires a power draw of 67kW. At 240 Volts the charge would call for 280 Amperes from the outlet which is highly impractical as it would require very heavy conductors. Another way to solve this issue is to use high voltage. This method though raises questions about the safety of the stations and the infrastructure necessary. In Tokyo, for example, they have installed several fast charging stations (very high voltage) along with many regular charging stations downtown.

The costs for a charging station depend on the location and the extra installation required. Coulomb Technologies estimates the costs of a charging station to be roughly \$2,500. Quick charging stations could cost roughly \$100,000. Total investment in charging infrastructure will also be massive, potentially totalling more than \$170 billion through 2030 (assuming at least 1 station is required per EV and each station costs \$2,000).

If you assume costs come down slightly (~\$2,000 per smart charging station) and are only installed at work and on streets, there will need to be a charging station for almost every EV. Additionally, you will need a charging system at home, inside your garage. Let's assume that these chargers cost \$300 (which is conservative, in our view), this would have to be factored into the cost of the vehicle. The on-street public charging stations and work-place stations will require massive infrastructure – but it may not impact the economics of purchasing an electric vehicle. Many cities are installing a limited number of charging stations and are providing free power.

Shopping malls, movie theaters, and parking garages may install charging infrastructure to attract customers. This may seem like a lost cause, but consider the business proposition: instead of having to send weekly circulars to customers to convince them to come to your grocery store, install a set of fast charging stations. Assuming each charging station costs \$10,000, it is utilized 12 hours each day, and each car stays for 45 minutes, the payback period will be 1.7 years. This assumes the coupons (which you can reduce) cost about \$1.50 per customer, while the electricity will only cost \$0.49. A movie theater is another example: install a set of regular charging stations (\$2,500 each), allow customers to charge their vehicles while they attend a movie. The payback for this scenario, even assuming the spots are occupied 6 hours for 4 days a week, is 3.2 years. These scenarios are illustrated below and do not take tax credits (50% credit for charging infrastructure) into account, which would cut the payback periods in half.

Exhibit 49: Charging Infrastructure Economics

	<u>Movie Theater</u>	<u>Grocery Store</u>	<u>Botique Store</u>	<u>Downtown Lot</u>
	Movie theater differentiation, vehicle charged	High turnover fast charging stations, reduced expense on coupons to generate traffic	Low Volume with high customer retention costs	Ability to command a premium for "free" charging
Capital Cost	\$2,500	\$10,000	\$2,500	\$2,000
Average Parking Space Utilization	6 hrs/day	12 hrs/day	3 hrs/day	8 hrs/day
Days Utilized per Week	4 days/wk	7 days/wk	6 days/wk	5 days/wk
Power Draw while Charging	1.9 KW	7.2 KW	1.9 KW	1.9 KW
Cost of Electricity	\$0.09/KWh	\$0.09/KWh	\$0.09/KWh	\$0.09/KWh
Average Duration per Vehicle	2.5 hrs	0.75 hrs	1.5 hrs	8.0 hrs
Incremental Vehicles per Day	2.4 cars	16.0 cars	2.0 cars	1.0 cars
Total Daily Cost of Electricity	\$ 1.03	\$ 7.78	\$ 0.51	\$ 1.37
Average People per Car	2	1	1	1
Cost to attract/retain each customer	\$ 0.21	\$ 0.49	\$ 0.26	\$ 1.37
Displaced Marketing Spend per Customer	\$ 1.00	\$ 1.50	\$ 3.00	\$ 3.00
Incremental Savings per Customer	\$ 0.79	\$ 1.01	\$ 2.74	\$ 1.63
Total Value Created per Year	\$ 785.0	\$ 5,905.5	\$ 1,711.9	\$ 424.3
Payback Period	3.2 yrs	1.7 yrs	1.5 yrs	4.7 yrs
<i>*note: Downtown parking lot displaced marketing spend represents the incremental daily rate that can be charged</i>				
<i>*note: Does not include any tax incentives, V2G incentives (for "smart charging") or TOU rates</i>				

Source: Credit Suisse estimates

In terms of battery replacement we know that Better Place is planning on gradually installing battery exchange stations throughout a city (we have heard numbers of about "three to four" swapping stations per city). The battery replacement should take no longer than three minutes and is fully automated. Next to the enormous costs of approximately one million dollars per station the compatibility with other vehicles and their batteries is the main issue.

Shifting Economics with Vehicle to Grid Storage

While the topic of vehicle-to-grid benefits is admittedly futuristic, it does present some compelling opportunities. Since electricity demand fluctuates very quickly, a grid operator has to respond quickly to maintain the frequency of the power at 60 Hz. This is done by providing regulation – absorbing or supplying power extremely quickly. In the PJM market in the US, for example, a signal is sent every 4 seconds to generators. Electric vehicles present a unique opportunity since they could quickly respond to signals to stop charging or increase their charging.

Grid regulation will become even more important as the penetration of renewable resources, such as wind and solar, increases. Wind farms are notorious for suddenly reducing their output when the wind stops blowing. We think that once the infrastructure is in place and there are enough electric vehicles, monetizing the value of the distributed storage will be inevitable. Using observed pricing for regulation capacity from PJM in July 2009, we find that it would be conservative to assume an electric vehicle owner could expect nearly \$338 per year in compensation. This assumes that another company aggregates all of the electric vehicles and bids the capacity into the market, knowing what percent of the vehicles can be expected to be charging at any given time. The aggregator can only use 50% of the EV's battery and splits the payments 50% with the customer.

Exhibit 50: V2G Scenario Assumptions and Regulation Prices

		Hour	Average Regulation	% vehicles connected	Connected Capacity	Regulation Value
			Clearing Price			
EVs	10,000					
Battery Size	20 KWh	1	\$30/MWh	70%	70 MW	\$ 2,127
% Battery Available when connected	50%	2	\$38/MWh	70%	70 MW	\$ 2,647
Capacity Available when 100% charging (MW)	100 MW	3	\$29/MWh	60%	60 MW	\$ 1,744
Average Rate	\$27/MWh	4	\$34/MWh	50%	50 MW	\$ 1,718
Daily Value of Capacity	\$ 18,495	5	\$34/MWh	40%	40 MW	\$ 1,348
Aggregator Fees	50%	6	\$45/MWh	30%	30 MW	\$ 1,364
Yearly Payments to EV Owner	\$ 338	7	\$48/MWh	20%	20 MW	\$ 961
		8	\$43/MWh	5%	5 MW	\$ 215
		9	\$36/MWh	0%	0 MW	\$ -
		10	\$27/MWh	5%	5 MW	\$ 136
		11	\$21/MWh	5%	5 MW	\$ 103
		12	\$17/MWh	5%	5 MW	\$ 86
		13	\$14/MWh	5%	5 MW	\$ 70
		14	\$12/MWh	5%	5 MW	\$ 61
		15	\$13/MWh	5%	5 MW	\$ 67
		16	\$12/MWh	5%	5 MW	\$ 59
		17	\$15/MWh	5%	5 MW	\$ 75
		18	\$13/MWh	5%	5 MW	\$ 66
		19	\$18/MWh	5%	5 MW	\$ 92
		20	\$19/MWh	5%	5 MW	\$ 97
		21	\$23/MWh	10%	10 MW	\$ 229
		22	\$21/MWh	30%	30 MW	\$ 640
		23	\$33/MWh	50%	50 MW	\$ 1,669
		24	\$49/MWh	60%	60 MW	\$ 2,924

Source: Data from PJM, Average Hourly Regulation Pricing from July, 2009, Credit Suisse Estimates

These incentive payments can shift the economics. If you receive a credit of \$338 per year and battery costs reach our long-term goal (\$500/KWh), electric vehicles make economic sense to own, even at \$3/gallon gasoline and without any government incentives.

Exhibit 51: Vehicle-to-Grid Can Shift Economics

	Gasoline	EV	EV	EV
	\$3 gasoline	Near Term Battery prices, no incentives, no V2G credits	Near Term Battery prices and no tax credits	Long term battery price and V2G credits, but no incentives
Base Car Price	\$ 18,500	\$ 18,000	\$ 18,000	\$ 18,000
Battery Costs	\$ -	\$ 18,000	\$ 18,000	\$ 10,000
Tax Credit	\$ -	\$ -	\$ -	\$ -
Purchase Costs	\$ 18,500	\$ 36,000	\$ 36,000	\$ 28,000
Gasoline Price	\$ 3.00	na	na	na
Electricity Price	na	\$ 0.10	\$ 0.10	\$ 0.10
Battery Price	na	\$ 900	\$ 900	\$ 500
Annual Fuel Costs	\$ 1,406	\$ -	\$ -	\$ -
Annual Electricity Costs	\$ -	\$ 500	\$ 500	\$ 500
Annual Maintenance	\$ 607	\$ 425	\$ 425	\$ 425
V2G Credit	\$ -	\$ -	\$ (338)	\$ (338)
Annual Costs	\$ 2,013	\$ 925	\$ 587	\$ 587
PV Total costs	\$ 34,829	\$ 43,502	\$ 40,764	\$ 32,764
Cost per mile	\$ 0.232	\$ 0.290	\$ 0.272	\$ 0.218

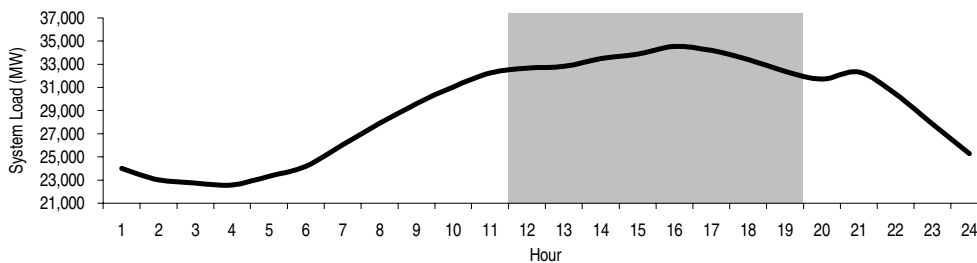
Source: Credit Suisse estimates

Vehicle-to-grid and peak power

Unlike fuel cell or hydrogen based cars, PHEVs would not need to have a full-scale build out of new infrastructure to support them. Additionally, the vehicles could theoretically sell power back to the grid (called V2G or vehicle-to-grid) during peak times. Each car could become a mini energy storage device, taking in low-cost energy overnight while potentially pumping it back into the system at peak demand times. This arrangement is known as vehicle-to-grid (V2G). By some estimates, as the United States grows, the need for over 100 full sized power plants could be eliminated if hybrid electric vehicles were adopted. The vehicles would recharge primarily at night, when generating capacity is available from inexpensive base-load sources.

The graph below shows that daily peak demand of electrical power occurs typically in midafternoon and is nearly twice the level experienced overnight. One characteristic of wind energy is that it is also productive at night, when energy demand is the lowest. Being able to store that energy and supply it back into the system in midafternoon (or simply delay charging until late at night) adds one more positive to electric vehicles.

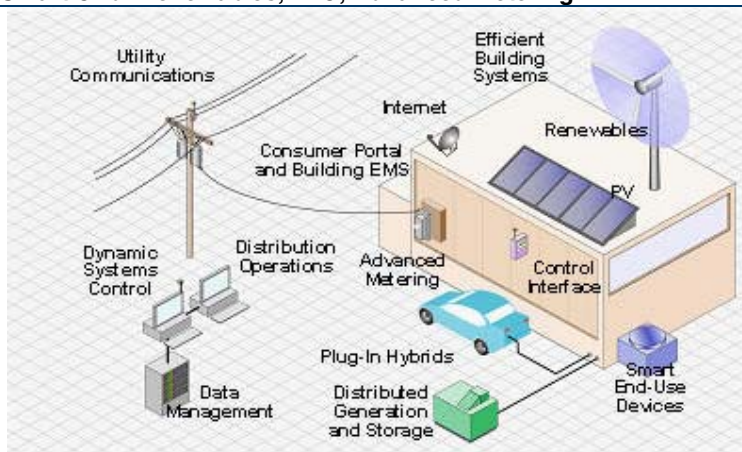
Exhibit 52: Typical Daily Power Demand



Source: CAISO, Company data, Credit Suisse estimates

Assuming that sufficient batteries become available at a low enough cost and with high enough energy density, the journey to V2G then is not over. How do we change the utility rate structure to accommodate buying energy from electric vehicles? Do we integrate demand response programs in those peak periods when the supply and demand are not in balance? We have to build out a network of smart meters and develop a national system to account for hybrid's mobility, much like today's wireless network. The envisioned structure would look like the diagram below, incorporating many advanced technologies in one connected system.

Exhibit 53: Smart Grid: Renewables, V2G, Advanced Metering



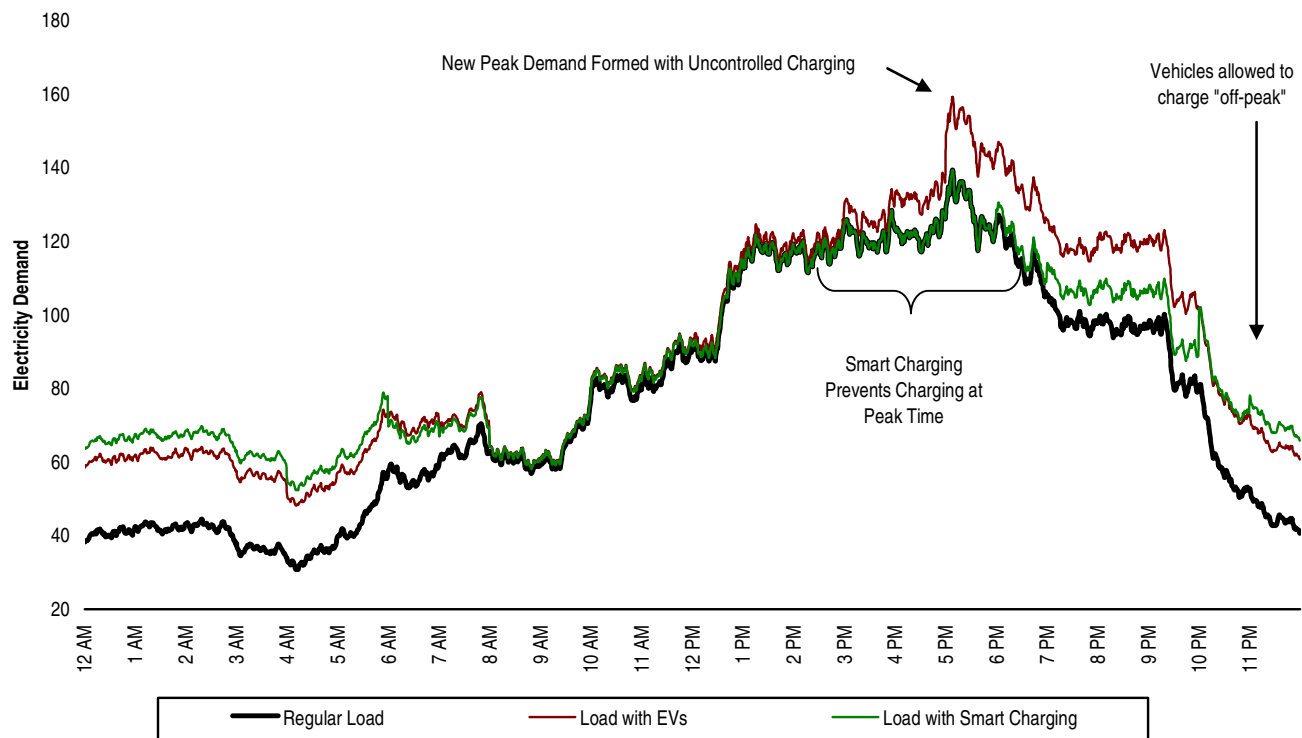
Source: Company data, PG&E, Credit Suisse estimates

While there will be challenges in responding to an increased electric load from electric vehicles, we believe that this will not present a major obstacle – assuming smart charging is enforced. There will have to be smart charging in place to ensure vehicles charge overnight when there is ample generation capacity. Additionally, there will have to be upgrades to transformers and capacitor banks that serve each house, as an electric vehicle is a substantial load.

An electric vehicle will draw roughly 1-4 KW of power while charging, roughly the same as a clothes dryer. Plugging in your electric vehicle would be about the same as two dishwashers. While this is manageable, the issue develops when everyone drives home and starts charging their vehicles immediately, increasing the peak demand for the region (having overall demand exceeding generation capacity) and straining distribution assets. This problem is exacerbated if consumers install fast charging (~240V) outlets, which charge the vehicles faster but draw more power. Additionally, adoption will not be uniform – certain cities, neighbourhoods, and even blocks will have different adoption rates. According to a study by the Electric Power Research Institute (EPRI), if every utility customer owned an electric vehicle and charged during peak times with a 30A charger, roughly 65% of the electricity distribution assets (transformers, etc.) would be strained.

To tackle the issue of peak demand, a smart charging system needs to be in place. The following figure depicts that would occur if a region experienced uncontrolled charging of electric vehicles. If the electric vehicles can be controlled or notified when to charge, the peak demand growth can be eliminated.

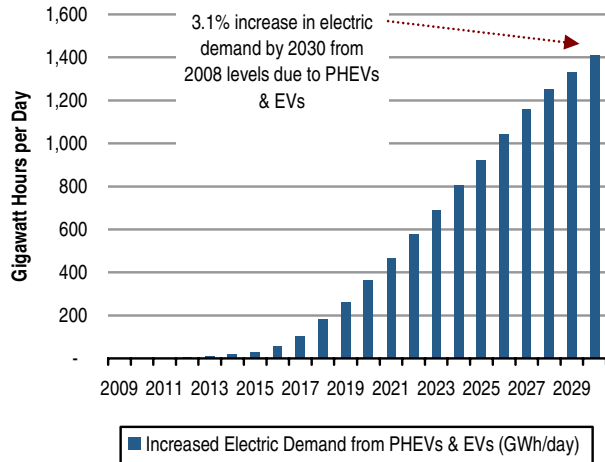
Figure 54: Peak Load Shifts, Smart Charging Required



Source: Credit Suisse Estimates.

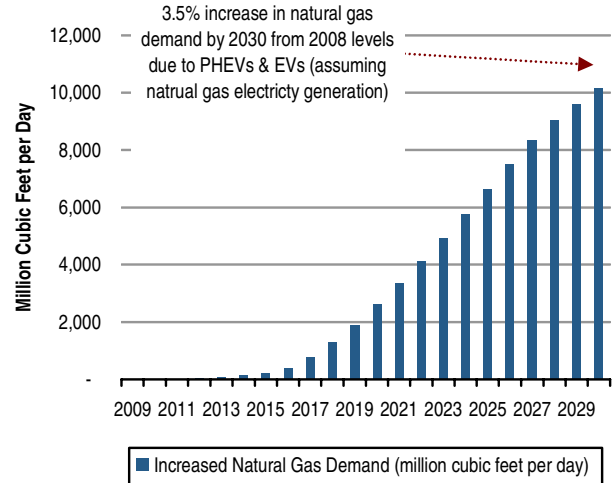
Generation capacity would only need to be built if electric vehicles cause a new peak in demand. Overall, using our estimated adoption rates and the life of each vehicle, electric consumption would increase 1.4 TWhrs per day by 2030 (representing a 3.1% increase from total worldwide consumption in 2008). Assuming all the electricity comes from natural gas power plants with a heat rate of 7.2 mMBTU/MWh, there would an increase in natural gas demand of 10.2 billion cubic feet per day (oversimplifying the generation capacity of each country, as well as the likelihood of renewable off-peak generation).

Exhibit 55: Global Increases in Electric Demand



Source: Credit Suisse estimates

Exhibit 56: Global Increases in Natural Gas Demand



Source: Credit Suisse estimates

Investing in Electric Vehicles

As we detail below, as investors appreciate the potential growth of PHEV's, HEV's and EV's, the stocks associated with this growth have begun to consistently outperform the global indices. Prior to this past year, as we see with many alternative energy names, these stocks had correlated most closely with oil prices, however that is beginning to change.

In this section, we look at the many companies involved with the growth of electric vehicles noting that the vast majority of them have only a small percent of their business in this area. While that may be the bad news, the better news is that the companies most likely to provide the IP, technology and market share leadership are the battery companies, and battery component suppliers. As well, metering companies and those involved in improving the grid are other potential investable ideas.

Exhibit 57: Substantial Market Capitalization to Invest within the Electric Vehicle Supply Chain

Prices as of 9/29/2009

Materials					Cells					Battery Packs					Components					Autos				
Lithium					Cells & Materials					Battery Packs					Components: Drivetrains, components, charging infrastructure, meters					Auto Manufacturers				
Company	Ticker	Market Cap	Comment		Company	Ticker	Market Cap	Comment		Company	Ticker	Market Cap	Comment		Company	Ticker	Market Cap	Comment		Company	Ticker	Market Cap	Comment	
Sociedad Quimica y Minera	SQM-US	\$ 10,362	~10% exposure to lithium		A123	AONE	\$ 1,839	IPO on 9/24/2009		AC Propulsion	private	-			BMW	BMW-DE	\$ 32,555			BYD Co.	1211-HK	\$ 18,157		
FMC Corp.	FMC-US	\$ 4,083			Altair Nanotechnologies	ALTI-US	\$ 123			Better Place	private	-	Infrastructure & battery leasing		Chrysler	private	-			Chrysler	private	-		
Rockwood Holdings	ROC-US	\$ 1,561	~17% exposures to lithium		Asahi Kasei	3407-JP	\$ 7,039	Separators		Borg Warner	BWA-US	\$ 3,565			Daimler AG	DAI-US	\$ 46,724	Daimler owns 6% of Tesla		Daimler AG	DAI-US	\$ 46,724	Daimler owns 6% of Tesla	
					Bosch	500530-IN	\$ 2,701	Investor in Cobasys with Samsung		Bosch	500530-IN	\$ 2,701			Fisker	private	-			Fisker	private	-		
					BYD Co	1211-HK	\$ 18,157			Continental AG	CON-DE	\$ 9,232			Ford Motor	F-US	\$ 24,127			Ford Motor	F-US	\$ 24,127		
					Celgard (unlisted)	private	-	Separators		Coulomb Technologies	private	-	Charging infrastructure		General Motors	na	-			General Motors	na	-		
					Chel Industries	001300-KR	\$ 2,191	Electrolytes		Echelon	ELON-US	\$ 561	Advanced metering		Honda	7267-JP	\$ 54,858			Honda	7267-JP	\$ 54,858		
					DOW Chemical	DOW-US	\$ 30,180	DOW Chemical partnered with Townsend Kokam		ECOTALITY	ETLY-US	-	Charging infrastructure		Hyundai	011760-KR	\$ 344			Hyundai	011760-KR	\$ 344		
					EnerDel	HEV-US	\$ 811			Enova	ENA-US	\$ 27	Drive systems		Mazda	7261-JP	\$ 3,329			Mazda	7261-JP	\$ 3,329		
					Furukawa Electric	5801-JP	\$ 2,922	Al / Cu foils (in electrodes)		ESCO Technologies	ESE-US	\$ 1,062	Advanced metering		Mitsubishi	7211-JP	\$ 9,161			Mitsubishi	7211-JP	\$ 9,161		
					GS Yuasa	6674-JP	\$ 3,278	Lithium Energy Japan (JV with Mitsubishi)		General Electric	GE-US	\$ 178,106	Resource management		Nissan Motors	7201-JP	\$ 29,306			Nissan Motors	7201-JP	\$ 29,306		
					Hitachi	6501-JP	\$ 10,654			GridPoint	private	-	Resource management		SAIC Motor	600104-CN	\$ 18,039			SAIC Motor	600104-CN	\$ 18,039		
					Kureha	4023-JP	\$ 1,105	Electrode materials		IBM	IBM-US	\$ 156,428	Resource management		Think	private	-			Think	private	-		
					LG Chem	051910-KR	\$ 13,326	Compact Power Inc is a subsidiary of LG Chem		Itron	ITRI-US	\$ 2,522	Advanced metering		Toyota	7203-JP	\$ 137,581			Toyota	7203-JP	\$ 137,581		
					Mitsubishi Chemical HD	4188-JP	\$ 6,431	Electrode materials, electrolytes		Johnson Controls	JCI-US	\$ 15,339			Volkswagen	VOW-DE	\$ 66,230			Volkswagen	VOW-DE	\$ 66,230		
					NEC Corporation	6701-JP	\$ 6,420			Sensus	private	-	Advanced metering		Volvo	VOLV-B-SE	\$ 19,404			Volvo	VOLV-B-SE	\$ 19,404		
					Nippon Denko	5563-JP	\$ 764	Electrode materials		Landis + Gyr	private	-	Advanced metering											
					Panasonic	6752-JP	\$ 36,603			Magna International	MGA-US	\$ 4,776	Motors and inverters, supplying Ford											
					Saft Groupe	SAFT-FR	\$ 1,044			MES-DEA S.A.	private	-												
					Samsung SDI	006400-KR	\$ 6,266			Rohm	6963-JP	\$ 8,235	Power devices											
					Sanyo Electric	6764-JP	\$ 4,562			Nidec	6594-JP	\$ 11,269	Electric motors											
					Sumitomo Metal Mining	5713-JP	\$ 9,387	Electrode materials		Raser Technologies	RZ-US	\$ 108	Electric motors, conversion systems											
					Toda Kogyo	4100-JP	\$ 388	Electrode materials		Silver Spring Networks	private	-	Resource management											
					Toshiba	6502-JP	\$ 21,550			UQM Technologies	UQM-US	\$ 160	Electric motors											
					Ube Industries	4208-JP	\$ 2,741	Electrode materials, separators, electrolytes																
					Valence Technology	VLNC	\$ 226																	

Source: Company data, Credit Suisse estimates

The most direct plays in this emerging area currently are the battery companies, specifically those that develop lithium ion expertise and can combine a good energy density with low manufacturing costs. Major battery companies, such as GS Yuasa, NEC, LG Chem, Panasonic, and Sanyo offer exposure to the batteries, which we believe will be one of the likely constraints for the next five years. Aside from battery manufacturers, investors can look to battery component suppliers such as Kureha, Nippon Denko, Toda Kogyo, and Ube Industries. There are also several U.S. companies, such as A123 Systems, Valence, and EnerDel, but they are not covered by Credit Suisse research.

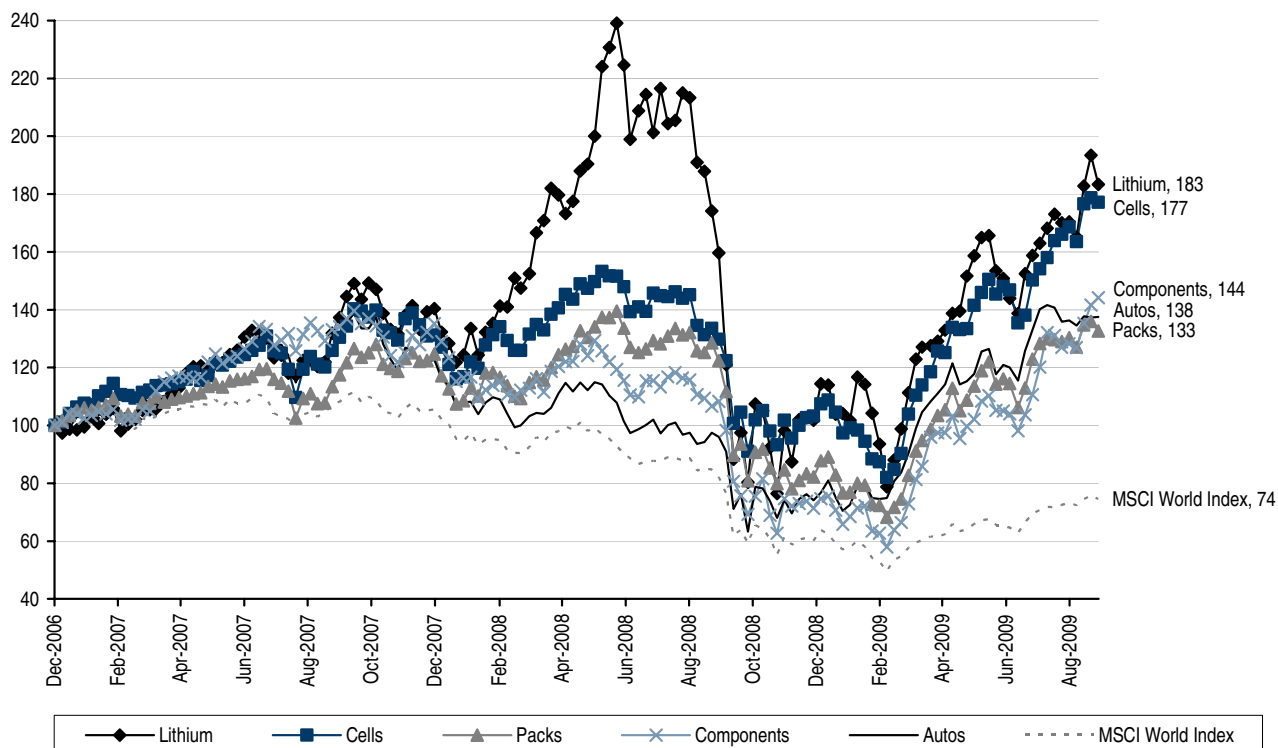
Another area that will likely benefit from the electrification of vehicles is the advanced metering and communication space. While this might not materialize until after electric vehicles hit the roads in large numbers, there will need to be a sophisticated system in place to properly manage the load on the electric grid as well as to realize the benefits from the distributed resource.

Electric motors, which require special magnets that contain rare earth metals, is another area that may benefit. One can also look to lithium producers like SQM, FMC, and Rockwood Holdings, although lithium represents less than 1% of the battery costs. A separate report by our Specialty Chemicals team has also been published today. We provide an excerpt in the appendix of the report. Lithium is not the only raw material – there is also a substantial amount of nickel and cobalt in lithium-ion batteries.

Investors have started to appreciate the increased likelihood of electric vehicle adoption. Each sector in the supply chain has outperformed during the past three years. The sectors that are likely to benefit the most have also seen the largest stock price appreciation. Lithium producers, battery cell and cell materials have increased by nearly 68% since December 31, 2006. Those industries will likely have the highest exposure to the electric vehicle end market and have a high likelihood of being a constraining factor in the industry's growth.

Exhibit 58: Supply Chain Stock Performance: Sectors with high exposure to EV growth have outperformed

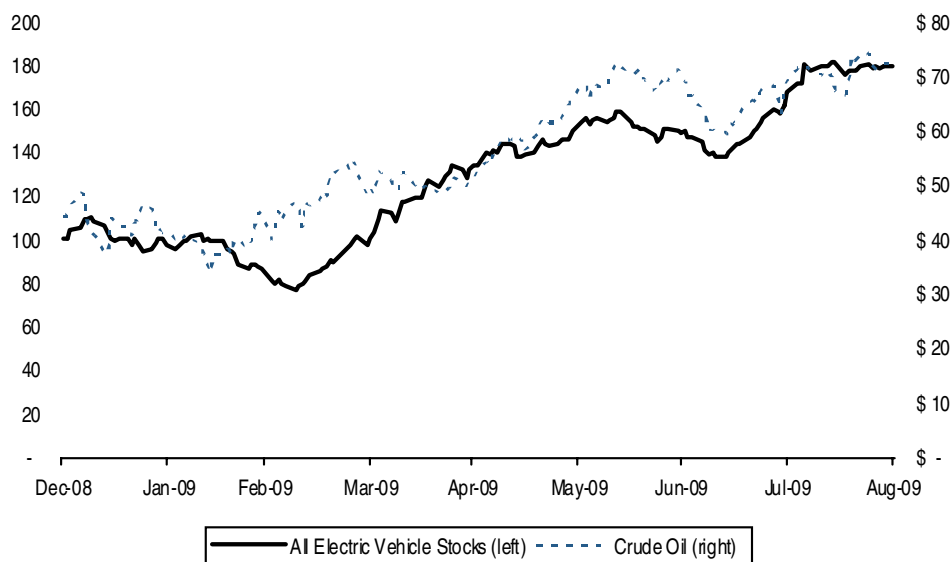
Prices as of 9/28/2009, Equal Weighted Indices



Source: FactSet

While the cell and battery manufacturers stand to benefit the most, in our view, they also offer considerable technology risk. If looking for exposure to the industry, oil appears to be an adequate proxy, at least in the near-term. Oil prices, which translate into higher fuel prices as well as economic growth prospects, have a high correlation with electric vehicle stocks.

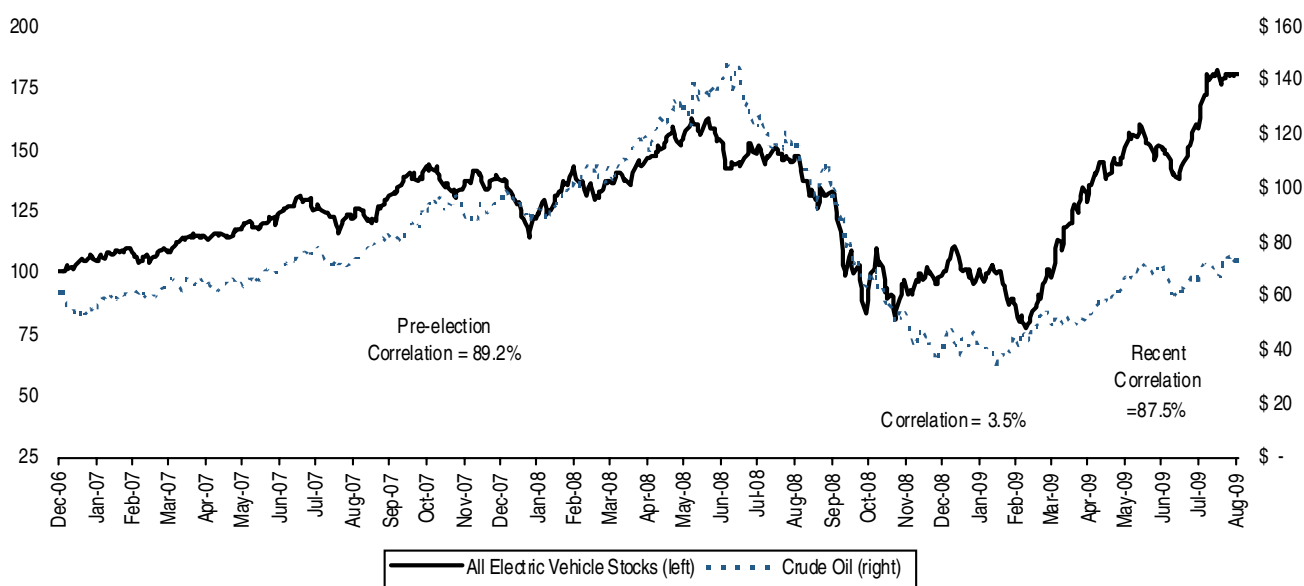
Figure 59: High Correlation with Oil



Source: FactSet

The recent correlation has been 87.5%. The correlation weakened during the U.S. presidential election, as oil declined while electric vehicle stocks appreciated. This was largely due to new policy measures that were introduced, along with President Obama's campaign promise to put one million PHEVs on the road by 2015 along with the shift away from hydrogen fuel cell vehicles.

Figure 60: Correlation with Oil

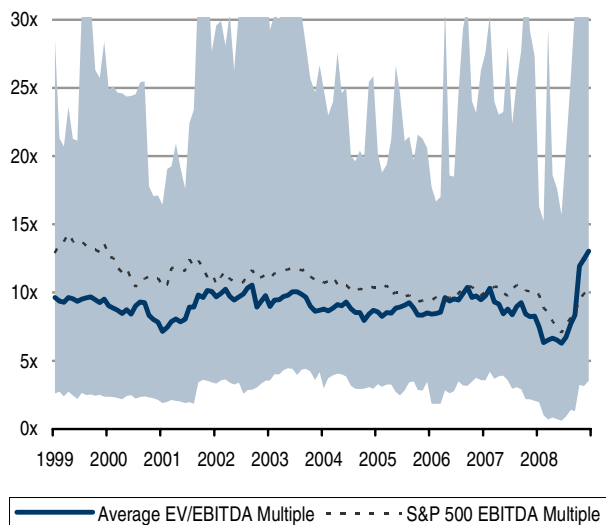


Source: Company data, Credit Suisse estimates

Valuations for the sector have increased substantially since April. The sector now trades at 13x current EBITDA, compared to its historic range of 6-10x.

Figure 61: Valuation Range

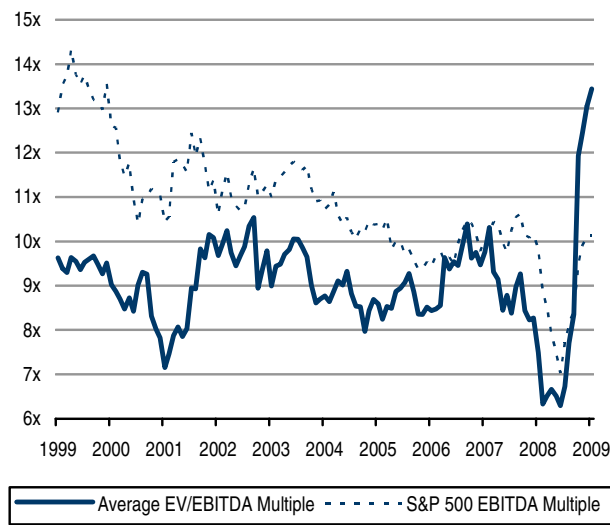
Range of Enterprise Value to Last Reported EBITDA Multiples



Source: FactSet, as of 9/28/2009

Figure 62: Electric Vehicle Valuations

Enterprise Value to Last Reported EBITDA Multiples

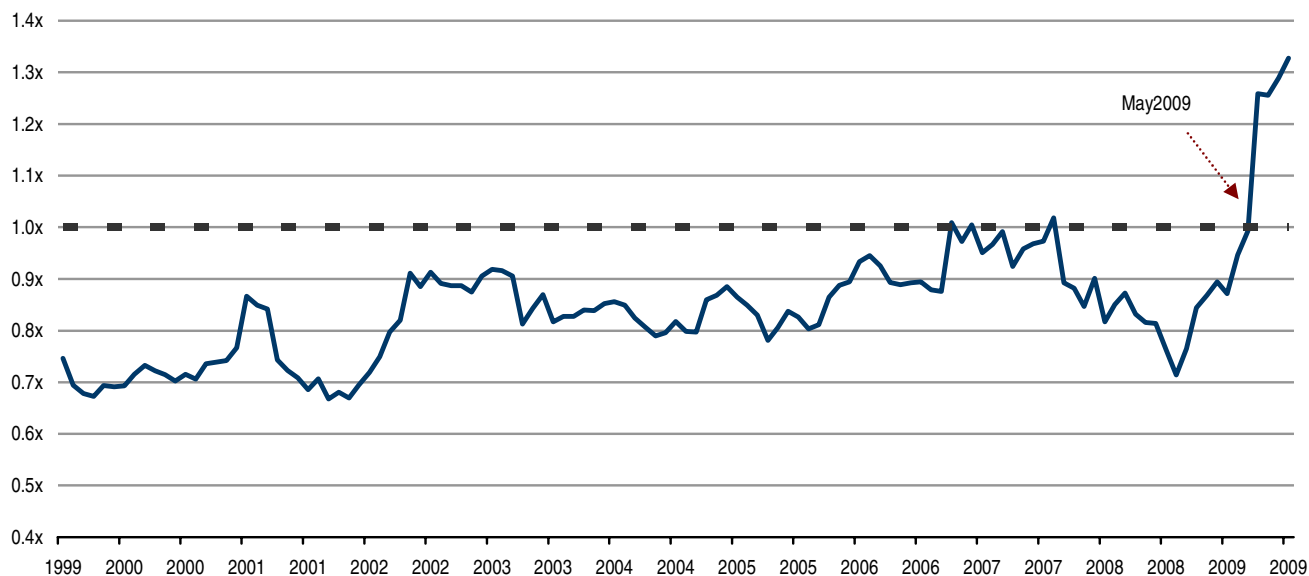


Source: FactSet as of 9/28/2009

Stocks related to electric vehicles have historically traded at a discount to the market. This trend has reversed, however, and the sector now trades at a 30% premium. This shift occurred during May 2009. **We believe that the adoption of electric vehicles will occur, and while valuations may be rich on current earnings, investors can start selecting names that will likely see material top-line growth in 5+ years within industries that will be able to defend margins.**

Figure 63: Prior to 2009, stocks exposed to Electric Vehicles have historically traded at a discount to the market

Relative Enterprise Value to last reported EBITDA, relative to S&P 500



Source: FactSet, as of 9/28/2009

Stock Picks

Our global analysts have put together their thoughts on individual stocks within their coverage that have exposure to electric mobility. We provide company-specific exposure to the sector and our viewpoint on the stocks. For more detail on stock specific recommendations, we refer you to the report published today by the Japan Technology and Materials team and the US Specialty Chemical team.

We believe the best areas to invest in this space are the chemical materials and component companies due to top-line growth and defensive margins, along with the battery companies that are able to retain their intellectual property. Our top long-term stock picks include BYD (1211 HK), Kureha (4023 JP), Nidec (6594 JP), Rohm (6963 JP), Furukawa Electric (5801 JP), Asahi Kasei (3407 JP), Mitsubishi Chemical (4188 JP), Ube Industries (4208 JP), Sanyo Electric (6764 JP), Panasonic (6752 JP), Johnson Controls (JCI US), and ON Semiconductor (ONNN US).

Exhibit 64: Credit Suisse: Top Stock Picks for Electric Vehicles

Sector	Ticker	Company	Market Cap (\$mm)	EV/TTM EBITDA	TTM Sales (\$mm)	Current Exposure	5-year Sales Exposure	Long-term Position	Analyst	12-Month Stock View
Autos	BMW-DE	BMW AG	\$31,725	8.6x	\$69,908	<1%	4%	eMini and Project I show BMW is taking EVs very serious. Medium term headwind on BMW's 8-10% autos margin target, but should have pricing power.	Arndt Ellinghorst	Outperform
Autos	DAI-US	Daimler AG	\$46,335	32.2x	\$110,221	<1%	2%	Daimler's stake in Tesla and its JV with Evonik supports its plan to push for EVs, should have pricing power	Arndt Ellinghorst	Outperform
Autos	VOW-DE	Volkswagen AG	\$66,230	6.6x	\$152,202	<1%	5%	Strongest OEM globally. Size and branding power should enable VW to become a leader in EVs, but still needs a EU battery supplier	Arndt Ellinghorst	Outperform
Autos/Battery	1211-HK	BYD Co. Ltd.	\$18,743	43.5x	\$4,469	<1%	21%	Both Battery & Auto company, exposure to China	Adrian Chan	Outperform
Battery	6752-JP	Panasonic	\$36,267	8.1x	\$74,716	2.4%	4%	Global top share in lithium ion batteries after TOB of Sanyo Electric. Also upwards of 90% market share in NiMH batteries for HEVs.	Koya Tabata	Neutral
Battery	6764-JP	Sanyo Electric	\$4,457	10.9x	\$17,318	1.5%	8%	Current global top share in small lithium ion batteries as well as #2 in automotive NiMH. Will become a subsidiary of Panasonic, for further synergies in energy business.	Koya Tabata	Neutral
Battery/OEM	JCI-US	Johnson Controls Inc.	\$15,446	13.3x	\$29,937	<1%	5%	Among best positioned for EV growth	Chris Ceraso	Outperform
Components	6594-JP	Nidec Corp.	\$11,819	13.8x	\$5,857	2.1%	~15%	Strong position to hold margins on brushless motors	Masashi Itaya	Outperform
Components	6963-JP	Rohm Co. Ltd.	\$8,092	17.0x	\$3,237	<1%	5%	Tailwinds due to strength in critical power components, particularly SiC-based power devices (have superior physical properties versus conventional Si-based power)	Masashi Itaya	Outperform
Materials	3407-JP	Asahi Kasei Corp.	\$7,163	8.4x	\$15,095	1.9%	2.4%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Neutral
Materials	5801-JP	Furukawa Electric	\$2,882	26.2x	\$9,457	1%	2.5%	Largest producer of copper foil for electric vehicles (50% market share)	Shinya Yamada	Neutral
Materials	4023-JP	Kureha Corp.	\$1,123	8.2x	\$1,435	2.1%	4.2%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Outperform
Materials	4188-JP	Mitsubishi Chemical	\$6,279	8.7x	\$27,931	0.5%	1.5%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Neutral
Materials	4208-JP	UBE Industries	\$2,661	9.7x	\$6,507	2.5%	6%	Best positioned for volume growth and sustained margins, even if batteries are commoditized	Masami Sawato	Outperform
Semis	ONNN-US	ON Semiconductor	\$3,402	11.8x	\$1,869	22%	~26%	Semiconductor company with 22% exposure to autos. EVs John Pitzer require roughly twice the dollar amount of semiconductors.	John Pitzer	Outperform

Source: Company data, Credit Suisse estimates

BYD – (1211 HK, Outperform)

- Exposure: BYD, originally a batteries and handset components maker, entered the automobile business in 2003 through the acquisition of XQC (not listed). Since then, the company has been dubbed the underdog of the Chinese automobile industry, given its lack of experience and scale. BYD Auto has grown aggressively over the years and is now the BYD's largest division, contributing up to 55% of total revenue and 80% of profit. With about 4% market share (in volume terms), BYD is one of the largest and most successful automakers in China. BYD Auto's brand is increasingly becoming

Adrian Chan

adrian.c.chan@credit-suisse.com

more well-recognised in China, evident by the booming sales of its conventional models such as F3, F6 and F0. BYD is also gaining fame, thanks to Warren Buffett's investment (through MidAmerican Energy) in the company. We believe these factors help form a solid foundation for BYD to launch both its hybrids (F3DM and F6DM) and pure electric vehicles (e6 and eBus). While we estimate such vehicles to contribute only 4% of the auto division's total revenue, they are an integral to BYD Auto's long-term growth.

- **Stock view:** Valuation: BYD has risen >600% in the past year on Buffett's involvement, surging sales, earlier-than-expected overseas launch of its new energy vehicles as well as the company's prospects in EV batteries, solar and wind power storage facilities. At 33x FY10E P/E, the current valuation does not spell cheap at first glance, but the stock is well-supported with an estimated 43% 3-year EPS CAGR (FY09-12) and is an exciting long-term growth stock that investors should accumulate on any pullbacks.

Johnson Controls (JCI US, Outperform)

- **Exposure:** JCI is the largest supplier of lead-acid automotive batteries in the world, and is seeking to position itself as a leader in lithium ion batteries. The company (through its joint venture with Saft) has production contracts in place to provide lithium ion batteries to Daimler (S class) and BMW (7 series). JCI could also benefit through the provision of stop-start battery technology to the extent those penetration rates increase. The company is a leader in so-called microhybrid technology through its absorbent glass mat technology.
- **Stock view:** We value JCI using our 2011 profit outlook, at which time we expect electric vehicle supply contracts to comprise a very small portion of the company's product mix. Based on our 2011 operating income forecast, our 12-month target price is \$26 per share.

Chris Ceraso

chris.ceraso@credit-suisse.com

Panasonic (6752 JP, Neutral)

- **Exposure:** Panasonic is exposed to the automotive battery market (both NiMH and Li-ion) through Panasonic EV Energy (PEVE), a 60-40 JV between Toyota and Panasonic. PEVE currently produces NiMH batteries for hybrids. Production capacity was 500,000 units in 2008 and 700,000 in 2009, and at end-2009, we expect it to reach 800,000 units. Including the Miyagi line, the company aims to be able to make around 1mn units per year by as early as 2010. In the area of automotive Li-ion, we expect PEVE to mainly supply its parent, Toyota Motor, but currently production capacity for is very low. We expect PEVE's sales of automotive Li-ion batteries to expand to ¥26.5bn in 2011, ¥97.0bn in 2013, ¥183.9bn in 2015 and ¥270.0bn in 2020. In terms of profits, we believe margins on Li-ion batteries will be similar to those on NiMH batteries in the early stages – when high levels of capex and R&D expenses pushed down earnings. Panasonic plans a TOB of Sanyo Electric, the global leader in small Li-ion batteries for use in notebook PCs, mobile phones etc. When combined with Sanyo, we expect Panasonic's market share in automotive Li-ion batteries to exceed 20% in 2020.
- **Stock view:** We rate the stock NEUTRAL with a ¥1,600 TP. Overall earnings are brisk, but structural reform measures and effects remain somewhat unclear, as the Sanyo Electric TOB looms ahead. The company will likely become more attractive as a mid-long term investment after its annual Business Strategy meeting in January, during which its growing B-2-B business will be highlighted as an earnings driver.

Koya Tabata

koya.tabata@credit-suisse.com

Sanyo Electric (6764 JP, Neutral)

- **Exposure:** Sanyo Electric is the global number one producer of small Li-ion batteries for use in notebook PCs, mobile phones etc. The company is now at the stage where we expect it to increase investment in HEV batteries in response to the increase in demand for HEVs (production capacity of NiMH battery cells to increase from 1mn

Koya Tabata

koya.tabata@credit-suisse.com

cells per month in FY08 to 3.5mn cells per month by end-FY09). The main differences with the company's competitors are: (1) the company is maintaining its competitiveness while generating steady cash flows in the consumer Li-ion batteries business, (2) the HEV NiMH battery business has finally started to generate profits and (3) the company aims to commence production of automotive Li-ion batteries at its Tokushima plant within the year. From the cash-flow viewpoint, we expect the same kind of start-up costs for the automotive Li-ion batteries business as for other companies within the industry, but with its consumer Li-ion battery and HEV NiMH battery businesses, the battery business as a whole should be able to generate sustainable positive cash flows. We expect sales of automotive Li-ion batteries to expand to ¥215.8bn by 2020, and shall be concentrating on margins in this area in the future.

- **Stock View:** We rate the stock NEUTRAL with a ¥220 TP. Holds strong technology in automotive NiMH batteries. As competition intensifies for automotive Li-ion batteries, we focus on whether it can maintain strong market share.

GS Yuasa (6674 JP, Underperform)

- **Exposure:** GS Yuasa's traditional businesses include manufacturing of automotive lead-acid batteries and industrial power supplies. The company has also been producing lithium ion batteries for industrial purposes for several years, and from 2009 began mass production of automotive lithium ion batteries (starting with batteries for Mitsubishi Motors' EV, iMIEV) at a joint venture named Lithium Energy Japan (LEJ). The company also has a JV with Honda motor named Blue Energy where they will produce batteries for hybrid cars from fall 2010. We forecast the automotive lithium ion battery business to generate ¥4.9bn in revenue (2% of consolidated sales) in FY3/10 and for it to grow to ¥100 (26%) in FY3/16 and ¥164 (34%) in FY3/21. Despite this rapid growth in sales, the bulk of the company's profits will continue to be generated from its more profitable traditional businesses. GS Yuasa faces the challenge of adapting to a business environment in which many of its rival battery makers come from the technology sector where business decisions are made more quickly and capex scale is larger. Otherwise, it faces the risk of becoming a niche player without sufficient scale for high, sustained profitability.
- **Stock view:** The stock currently trades at 4.6x FY3/11 P/B, 107x FY3/11 P/E. We think that the expectations for the lithium ion battery business built into the share price are at excessive levels. That said, the stock is a favourite of retail investors as an environmental play and the share price tends to be volatile.

Jun Yamaguchi

jun.yamaguchi@credit-suisse.com

LG Chem (051910.KS, Neutral)

- **Exposure:** LG Chem has been a relatively early mover- currently, the company is supplying to Hyundai Motor Group for its LPG hybrid cars. LG Chemical also announced plans to set up a JV with Hyundai Mobis, the module maker within Hyundai Motor Group. The company signed a contract to supply batteries to GM's Chevy Volt and Buick, starting from end of 2010 until end of 2015. In August, various media reported that LG Chem would build a plant in Michigan. By deciding so, LG benefits from the US government's grant of U\$151mn and U\$130mn of tax credit from the state of Michigan. As per the company's official disclosure, they aim a W2tn (around U\$1.7bn) revenue from the business or 20% market share by 2015, by adding more contracts to supply lithium ion batteries. Capex plan is announced to be W1tn (U\$850mn) until 2013.
- **Stock view:** Based on our estimates, top line earnings contribution from the batteries for HEV/PHEV (not including the batteries for handsets/notebook PCs) is not likely to exceed 10% of the company by 2015. The stock is trading at 14x '10 P/E, 2.4x P/B with an ROE of 19% and 8.6x '10 EV/EBITDA. Valuation does not look that demanding, but we note that the company has not started generating revenue from

A-hyung Cho

a-hyung.cho@credit-suisse.com

the batteries for hybrid car business, and that stock price outperformed the market by 58% mostly driven by this business. We remain concerned about the slowdown of the existing business chemical business that takes up to 70% of its bottom line earnings.

Samsung SDI (06400.KS, Neutral)

- **Exposure:** After setting up a 50-50 JV with Bosch called SB LiMotive (SBLM) on September 2008, there has been a series of announcements on strategic alliances with others. On July 14, SBLM announced that it is acquiring 100% stake at Cobasys in the US, who has hybrid energy storage and pack technologies. On August 3, SBLM announced its EV/HEV battery supply contract with BMW of Germany from year 2013 to 2020. SDI indicates actual production of EV/HEV battery would take place from FY11/12.
- **Stock view:** While its core ROE profile would likely remain weak in the next few years, we believe that the street's estimates on the potential value of its EV/HEV battery operation also look overly optimistic. Its current stock price looks stretched and we rate the stock UNDERPERFORM with a target price of W135,000 based on 1) its historical mid-to-trough cycle 0.93x P/B (given still weak core ROE only with mid-single digit profile) and forecast book of FY09/10, 2) holding value of its affiliate equity stakes (W21,900/share), and 3) estimated PV of SDI's 50% stake in the EV/HEV battery business with Bosch (W22,000 /share).

John Sung

john.sung@credit-suisse.com

BMW (BMW DE, Outperform)

- **Exposure:** BMW is the leading carmaker when it comes to fuel efficiency (combustion engines). So far, BMW benefitted from engine downsizing implementing technologies such as turbo charging, direct fuel injection and start-stop. The eMini and Project I mobility concepts suggest that management sees EVs as a significant technology moving forward.
- **Stock view:** BMW is the best play to benefit from improving end markets (US, BRIC and corporate customers), product and savings momentum and materially improved refinancing conditions. BMW sticks to its assessment that it can increase the profitability of its autos business from a previous cycle margin of 6%-8% to 8%-10% by 2012 (we expect 3.7% in 2010). Other 2012 automotive targets: >26% RoCE and >Eur2bn FCF remain in place. On normalised earnings (6% margin), the stock is trading on 2.5x industrial 2010 EV/EBITDA (historical average 3.8x).

Arndt Ellinghorst

arndt.ellinghorst@credit-suisse.com

Renault (RNO FR, Underperform)

- **Exposure:** Renault, alongside Alliance partner Nissan, is racing to becoming the first mass maker to offer a range of pure electric vehicles, devoting a \$4bn budget to the cause. A suite of 4 products are planned for launch by 2012, and could account for c.5% of revenues within 5 years, and 10-15% by 2010E, depending on government incentives. Renault aims to offer EV's at a similar price to conventional mass market vehicles, with the customer leasing rather than owning a battery. The cost of the lease should be competitive relative to fuel costs based on a \$100 oil price. In the meantime, Renault continues to persevere with fuel efficient ICE technology, and currently 70% of its sales have emissions under 140g/km, and 34% under 120g/km.
- **Stock view:** We continue to remain cautious on Renault shares with an Underperform rating. Our main short-term fear is a continued decline in 2010 end markets due to a likely overhang from scrappage schemes in Europe. Production plans may need to be cut, thus raising the risk of significant cash burn in 2010E. In the longer term, Renault's weak core brand and significant overcapacity (c.30%) pose structural barriers to returning its cost of capital. At 20% industrial EV/Sales for the core business, we do not think Renault cheap relative to its own trading history.

Stuart Pearson

stuart.pearson@credit-suisse.com

Daimler (DAI US, Outperform)

- Exposure: Similar to BMW, albeit with a delay, Mercedes is so far focusing on improved combustion engines technologies in order to improve fuel efficiency and comply with future European emission standards. It's 10% stake in Tesla and JV with Evonik (Li-Tec) suggest managements intention to a leading player in EVs. In addition, Daimler manufactures the most fuel efficient truck engine fleet (world market leader in trucks). Based on existing vehicle platforms, VW can already manufacture hybrid and EV powertrains.
- Stock view: Given an improved cash flow, a solid net cash position, better visibility on end-markets and tight cost management, investors are clearly right in pricing Daimler shares closer to the underlying fair value of the business. Even though we are still far away from valuations reflecting the company's 9% industrial margin target (this would drive our SOTP >€60), moving closer to a normalized 6% margin is justifiable in our view.

Arndt Ellinghorst

arndt.ellinghorst@credit-suisse.com**Volkswagen (VOWG DE, Outperform)**

- Exposure: So far, VW has a leading mass market position in efficient combustion engines (Diesel: BlueMotion, Gasoline: TSI direct injection). Longer term, VW sees the cost of lithium batteries declining by some 80% (by 2020) and it intends to manufacture battery systems in-house. Unlike Renault (Better Place) or BMW (Project I), VW is has not yet communicated a dedicated strategy in order to deal with a changed landscape for individual mobility.
- Stock view: Currently, VW is in process to combine its business with Porsche. In addition, Qatar Investment Authority is about to acquire some 17% in VW ord shares, limiting the free float of ordinary shares to below 10% (the state of Lower Saxony and Porsche families being the other key shareholders) Our 2010 SOTP valuation suggests a fair value of €86 for VW shares. To maintain a conservative stance, we account for a 20% discount for the non-voting shares. However, we note that this discount should be removed in case the ords' free float diminishes (What's the value of a minority vote in that case? Also, pref shares carry a 6cents higher dividend compared to the ords). We are accounting for net cash of €7.9bn within our VW valuation and expect VW's preference shares to replace ordinary shares in the German DAX index.

Arndt Ellinghorst

arndt.ellinghorst@credit-suisse.com**Ford Motor (F US, Neutral)**

- Exposure: Ford currently markets hybrid vehicles in the US including the Fusion and Escape. Its plans currently call for the introduction of a PHEV and EV over the next few years (2011 – 2012 timeframe). The company will increase its hybrid offerings over the mid-term as well.
- Stock view: We value Ford using our 2011 profit outlook, at which time we expect electric vehicles to comprise a negligible portion of Ford's product mix. Hybrid vehicles should account for an increasing percentage of total sales by 2011, but should still be a very small portion of the total. We maintain a Neutral rating and \$7 price target. To support a stock price much higher than the current level we would have to assume a 2011 profit margin that approaches prior peak levels of 10% or 11%. As it stands, we are already assuming an 8% EBITDA margin for 2011, which is well above Ford's ~4% average for the 2001 to 2007 period, and considerably higher than the ~6% average for the 1991 to 2007 period.

Chris Ceraso

chris.ceraso@credit-suisse.com

Rockwood Holdings (ROC, Neutral)

- Exposure: Under its subsidiary Chemetall, Rockwood has a fully integrated platform in lithium from the brines to lithium carbonate to high value downstream products including: lithium hydroxide, lithium nitrate, lithium chloride, butyllithium, and lithium aluminum hydride. The lithium business accounted for ~17% of ROC's revenues in 2008 with 75-80% tied to higher value downstream products and 20-25% tied to the more commodity grade upstream products. Rockwood also generates revenue from advanced materials, pigments, and additives.

John McNulty

john.mculty@credit-suisse.com

Sociedad Quimica y Minera de Chile (SQM, Underperform)

- Exposure: In 2008 roughly 10% of SQM revenues came from lithium but we expect to be around 8.5% in 2009 given the downturn in economic activity, which impacted sales of rechargeable batteries for electronic devices, glass ceramics, aluminum, etc. If the electric vehicle market develops in a sustainable way and we actually see the introduction of lithium batteries in this market, SQM would certainly see volumes increasing, as it's the most efficient player in the lithium business, with a ~30% market share. However, since the fertilizer business, which represents roughly 70% of its revenues, is also a strong growing business, we don't expect lithium to represent much more than 10% of revenues in the long term even with increasing lithium demand coming from the HEV market (unless lithium price hikes), which means that SQM earnings should continue to be driven mostly by potash prices. Based on our Global team lithium demand model, if SQM maintains its 30% share on total lithium sales, which seems to be the company strategy, its production capacity would have to reach ~60,000MT by 2020 versus the current 40,000MT. On the other hand, If the company does not expand its capacity, it would be able to absorb only 20% of the market by 2020. In our model we assume a 50,000 capacity by 2020, which translates into a lithium revenue CAGR for the 2009-11 period of 10% per year.
- Stock view: We have an Underperform rating on the stock and a target price based on a DCFE model of US\$30/share. Despite the compelling lithium story, price of potash is still the most relevant driver for earnings. Thus, given the weak potash market, we estimate depressed results in upcoming quarters, which should prevent shares from outperforming the market. Under our estimates the stock is trading at 26x P/E 2010 versus its peers at 14x.

Luiz Otavio Campos

luizotavio.campos@credit-suisse.com

Implications for Oil Stocks

- Our Oil Team's view on US gasoline demand is bearish due to the combination of expected improvements in fuel economy and renewable fuel standards. US oil demand is expected to shrink within the existing automotive technologies and a significant adoption of electric vehicles would further weaken US gasoline demand, posing a big problem for US refiners: gasoline accounts for around 45% of total US refinery yield. Besides the potential for electric vehicles, there are two important intersecting pieces of US legislation which will be driving much of the negative trend in gasoline consumption : the Renewable Fuels Standard (RFS) and the CAFE standard dealing with automotive mileage per gallon. If these were implemented as currently envisaged, they would push down average US gasoline consumption by between 1% and 2.5% per annum post 2010. The goal of adding significant amounts of advanced biofuels to the US mix is going to be too difficult to implement, we think, and the EPA will likely have to vary the RFS to a lower mandated amount than envisaged. . The CAFE standards, however, are likely to be enforced we believe, and there is plenty of evidence that US consumer preference is already headed in the way of more efficient vehicles. Whatever the reality of how biofuels and fuel efficiency interact with the potential for electric vehicles, it is difficult to paint anything other than a negative picture for US gasoline demand growth and, by implication, for US total oil demand.

Mark Flannery

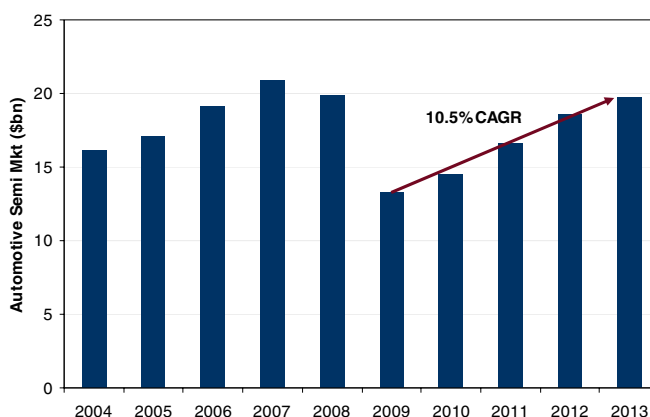
mark.flannery@credit-suisse.com

Semiconductor Beneficiaries

Notwithstanding the turmoil within the broader auto market, automotive semiconductors have been an area of increasing focus and investment for semiconductor companies, with the automotive semiconductor market sized at roughly \$20bn in 2008, or approximately 7.8% of the total semiconductor market according to Gartner, with most market research firms and industry experts expecting a CAGR in the high single digits to low double digits over the next several years (Gartner estimates a CAGR of 10.5% through 2013).

John Pitzer
john.pitzer@credit-suisse.com

Exhibit 65: Worldwide Automotive Semi Market Share (2008)



Source: Gartner, Company data, Credit Suisse estimates

Growth is being driven by shift from mechanical to electro-mechanical to electronic systems, and we expect semis to benefit from increasing semiconductor dollar content per vehicle as hybrid and electric vehicles gain traction. **According to Gartner, currently the average automobile contains roughly \$330 worth of semiconductor content. We believe that semiconductor content per vehicle for the average hybrid electric vehicle (HEV) and electric vehicle (EV) is currently 1.8x the non-electric vehicle at roughly \$600.** As such, we estimate that the automotive semi market would see an 11.3% expansion from hybrid and electric vehicles increasing from a negligible portion of the auto market currently to a CS's estimate of 13.8% combined share (based on a constant \$600 semi dollar content/HEV and EV vehicle). Below we show the sensitivity of the automotive semi market expansion based on varying assumptions for hybrid/electric vehicle penetration and average semiconductor dollar content per hybrid/electric vehicle.

Exhibit 66: Increase in Automotive Semi Market from HEV/EV Penetration

US\$ in millions, unless otherwise stated

Avg Semi \$ Per EV/HEV	Increase in Automotive Semi Market EV/HEV Penetration				
	10%	12%	14%	16%	18%
\$550	6.7%	8.0%	9.3%	10.7%	12.0%
\$575	7.4%	8.9%	10.4%	11.9%	13.4%
\$600	8.2%	9.8%	11.5%	13.1%	14.7%
\$625	8.9%	10.7%	12.5%	14.3%	16.1%
\$650	9.7%	11.6%	13.6%	15.5%	17.5%

Source: Gartner, Company data, Credit Suisse estimates

While we believe that currently, hybrid semi dollar content is marginally higher than electric vehicle content by roughly 5% from supporting both systems, and due to additional complexity around switching between electric motor and internal combustion engines, **we believe that advancements in electric vehicles will drive EV semi dollar content higher than HEVs going forward.** We expect most of the advancements will be seen in driving battery efficiency and lifespan, which we estimate could drive EV semi content 15-20% higher than HEV content. In this scenario, based on CS expectations for 7.9% EV penetration and 5.9% penetration expected for HEVs, we estimate that the automotive

semiconductor market should see expansion of 13.8%, 250bps higher than our 11.3% estimate above. Again, we show a sensitivity around the potential market expansion - every additional 1 percentage point penetration from HEVs drives roughly 80bps expansion of the automotive semi market, and each 1 percentage point penetration from EVs drives 110-120bps market expansion.

Exhibit 67: Increase in Automotive Semi Market from HEV/EV Penetration

HEV Penetration	Increase in Automotive Semi Market				
	EV Penetration				
	6%	7%	8%	9%	10%
4%	10.1%	11.2%	12.4%	13.5%	14.6%
5%	10.9%	12.0%	13.2%	14.3%	15.5%
6%	11.7%	12.9%	14.0%	15.1%	16.3%
7%	12.5%	13.7%	14.8%	16.0%	17.1%
8%	13.4%	14.5%	15.6%	16.8%	17.9%

Source: Gartner, Company data, Credit Suisse estimates

Largest Players and Favorite Plays: Gartner estimates that the largest automotive semiconductor players are Freescale Semi, with 8.8% share of the automotive semiconductor market in 2008, followed by Infineon at 8.5%, STM at 7.4%, Renesas at 7.1%, and NEC with 6.7%.

Exhibit 68: Worldwide Automotive Semi Market Share (2008)

Company	2008 Share (%)
Freescale Semiconductor	8.8%
Infineon Technologies	8.5%
STMicroelectronics	7.4%
Renesas Technology	7.1%
NEC Electronics	6.7%
Total Market	100.0%

Source: Gartner, Company data, Credit Suisse estimates

Within our coverage, we highlight ONNN, Microchip, and Linear with the largest exposure to the auto end market at 22%, 16%, and 10%, respectively. While National Semiconductor's exposure to autos is currently relatively limited at 4.3%, we would note that National has 25 Powerwise circuits in the power electronics module (PEM) of the Tesla Roadster, an all-electric vehicle introduced in 2008. NSM sees considerable opportunities from the HEV/EV market going forward; and has highlighted its Smart Energy Management Systems (SEMS, which uses similar technology to as the company's SolarMagic product) to improve battery efficiency and life for use in electric vehicles – the product is expected within an 18 month timeframe.

Exhibit 69: CS Coverage: Automotive Exposure (2008)

Company	Auto Exposure	Mkt Share
ON Semiconductor	22.0%	2.3%
Microchip	15.6%	0.8%
Cypress	13.3%	0.5%
Linear Technology	9.5%	0.6%
Analog Devices	6.9%	0.8%
FCS	6.0%	0.5%
Texas	5.5%	3.5%
Micrel	5.0%	0.1%
National Semiconductor	4.3%	0.4%
Intersil	4.0%	0.2%
Maxim Integrated Products	3.8%	0.4%
Total Auto Market		100.0%

Source: Gartner, Company data, Credit Suisse estimates

How will the traditional car business model survive?

The car industry has been called dead many times. And truly, the implications from an increasing penetration of electrical vehicles are a material challenge for the business model of a traditional carmaker in our view. To be clear: a majority of mass producers already destroy value across the cycle, the most recent downturn has moved many players at the edge of financial distress and the industry has still not consolidated (ie capacity utilization remains too low). And the path to electrified mobility is costly with the majority of costumers hardly being willing to pay a premium for cleaner mobility. In other words: technological progress will likely **further separate the weak from the strong players**. In the light of the electrical vehicle, **R&D power (scale) and pricing (branding)** will become even more important drivers for fundamental performance.

Arndt Ellinghorst
arndt.ellinghorst@credit-suisse.com

In order to comply with European emission standards, carmakers already need to stomach €800-€1,500 higher variable costs per vehicle. The dilemma becomes evident when highlighting that these add-on costs exceed the operating profit a mass maker is realizing (or not) per car.

Leaving “easy” to predict near term factors such as increasing R&D and variable costs aside, the bigger question is how the entire value chain and business model of traditional carmakers will change.

The engineering power, understanding of mobility and its customers make carmakers best positioned in order to lead the process of cleaner mobility in our view. But the industry has to accept that “petrol heads” are better suited to manage niche operations rather than global car manufacturing operations in future.

Will cars lose their emotional appeal? Unlikely in our view – individual mobility will remain the main area for people to show their taste, social status or simply have fun. But premium products will have to change from offering “power and luxury” to “superior, clean and luxury mobility”. Alongside this transformation, customers might be more attracted by being a member of the ie “BMW superior mobility club” (offering a wide range of products and services for a monthly fee) rather than owning one specific vehicle.

Other imminent changes

- R&D costs: These will have to materially increase by at least 100-200bps from currently 4%-5% of sales for mass makers and 5%-6% for premium makers.
- Variable costs: As long as lithium-ion battery costs are in the area of US\$900/KWh (as projected for 2012) to US\$500/KWh (as projected for 2020) electrical vehicles will only be affordable for a small group of customers with an average annual income of US\$200-300k per year. Full electric vehicles need batteries with c20KWh.
- Pricing: Even if total-cost-of-ownership (TCO) is attractive, consumers are unlikely willing to pay a 50% to 100% premium for an EV versus a traditional car. New ways of selling cars are needed (selling mobility packages, leasing the battery, etc).
- Brand identities: Especially (German) premium carmakers who's brand identities are pretty much based on combustion engine technology, power and performance need to address their future brand pillars. Within the world of EVs, acceleration, speed and performance will likely become a commodity attribute of a vehicle.
- Intellectual property: Car makers have already outsourced some 30%-40% of the value creation of a vehicle to suppliers. The remaining captive know-how is mostly linked to developing combustion engines.

The automotive value chain has not experienced any material, structural change over the past decades. Yes, there was a trend to outsource value creation to suppliers in order to benefit from more specialized and scaleable manufacturing processes. But the players have pretty much been the same for a very long time.

This will likely change. New players such as battery makers and utility companies need to be integrated into the existing value chain. While currently carmakers develop, manufacture and sell cars (out of which only very few generate value over the cycle), the future business model could become much more focused on selling/renting individual mobility.

There is no choice...

The need for clean individual mobility is obvious and governments across the globe are committed to reduce dependency on natural energy resources and emissions. In this light, we believe carmakers have no choice but to prepare for a change in powertrain technologies and the business model of selling cars. Whereas previously, carmakers were exploring all sort of different technologies from fuel cells to hydrogen technologies, meanwhile the vast majority of R&D is being focused on electrical vehicles, which increases the likelihood that this technology could replace combustion engines.

In our view, no carmaker can afford to stand on the sideline. Financial and branding (ie pricing) strength rather determine whether carmakers are early or late movers in the field of electric vehicles.

Which carmakers are best suited for the EV world?

In general, Asian and German carmakers have the most robust balance sheets and engineering power in order to be a part of a world with electrical mobility. We see the risk that European and American mass makers will struggle to finance front-up expenditure and if they do, price hiking variable costs to their customers.

Besides scale and R&D capabilities, access to battery know how and pricing power will be the core elements of the competitive landscape in our view. Whilst Asian carmakers should benefit from being close to world leading lithium-ion battery know-how, German premium maker should be well positioned to pass on increasing costs to their customers.

Figure 70: Positioning of car manufacturers (groups) in the EV world

Company	Comment
Toyota	Leader in the electrification of vehicles. Battery partnership with Panasonic. Late adopter of Lithium ion batteries due to safety concerns. Has the size and balance sheet to be market leader.
Renault/Nissan	Unlike Toyota, not big fans of hybrid vehicles. The LEAF will be the first full EV. Partnership with NEC on batteries. Has the size but limited balance sheet to be market leader.
BMW	Leader in fuel efficient combustion engine technology (mostly downsizing gasoline engines). Has the pricing power and balance sheet for strong R&D commitment. Scale is limited, might need a partner. Battery supply needs to be addressed.
Daimler	Has the pricing power and balance sheet for strong R&D commitment. Scale is limited, might need a partner. Battery supply needs to be addressed.
Volkswagen	Clearly has the scale and balance sheet to be a EV leader. Compared to peers no unique EV strategy. Battery partner needs to be addressed.
GM	The VOLT is clearly an ambitious and industry leading project. Scale should not be a problem, but balance sheet raises the question of future R&D spending and breath to support EVs
Ford	Is expected to launch a 21KWh EV in 2010. So far not a major differentiating factor for Ford. Similar to GM, clearly has the scale but maybe not the cash to be a leader.
Fiat/Chrysler	So far no major projects. Question whether balance sheet and scale will be sufficient to be a competitive player in EVs. Pricing power is limited.
Peugeot SA	Has announced an EV alliance with Mitsubishi recently. So far no major player. Even with new JV scale and balance sheet remain weaker compared to peers.
Hyundai/Kia	No major projects in place. Questionable whether both have the pricing power to make customers paying for EVs.

Source: Company data, Credit Suisse estimates

Entirely New Business Models

We believe that electric transportation will play an important role in our energy future. The extent of adoption will depend on many factors, such as the economics and political support. Instead of selling cars solely on sticker price and technical specifications, auto manufacturers will have to embrace selling the total cost of ownership instead of the base MSRP. This will be a substantial shift in their business models. We will probably also see an emergence of new business models, such as battery leasing, charging infrastructure, and resource management companies.

Better Place

One of the more interesting battery car business models is that offered by Shai Agassi's venture backed company Better Place. They are focusing on a 100% gas-free transportation and zero emission transportation solution by creating a market-based transportation infrastructure. Better Place has partnered with Nissan-Renault to supply electric vehicles that can swap batteries in less time than it takes to fill your gas tank. Better Place has announced to distribute their system in Israel, Denmark, Australia, California, Hawaii and Canada. By centralizing the charging mechanisms, Better Place then partners with major utilities in those markets to utilize off-peak power. Better Place's battery swap stations (akin to gas stations) effectively extend the range offered by electric vehicles. Charging stations would also be installed at each subscribers' home and workplace, along with many public places. The range of the cars running on just one lithium-ion phosphate battery is between 100-120 miles. The consumer will pay for the miles driven with a pricing model similar to the mobile phone providers'. The issues with this project are the huge capital requirements for the battery exchange stations and the batteries. Gradual penetration is not an option. The project requires a rapid deployment of the region with the necessary infrastructure. We therefore believe a partnership with other charging station providers would make sense to penetrate in non-isolated regions. To cover the high investments, Better Place has raised \$200 million. They are moving towards wide-scale deployment in 2011 and are in talk with more than 25 additional countries around the world. We note, however, that this does not solve the issue of expensive batteries. Also, even if they have the intro, will an auto manufacturer want to produce just for Better Place?

Better Place estimates that there are 700 million cars producing 2.8 billion tons of carbon dioxide (CO₂) annually. If all of these vehicles were electric, running on renewable or carbon free electricity, that would reduce global anthropomorphic CO₂ emissions by approximately 10%. Realistically, given that most electricity is currently powered by fossil fuels, the savings without a smart grid to smooth energy requirements for charging will be much lower. That is one reason why Better Place is working primarily with countries and states willing to make the necessary investments in the grid.

Depending on how Better Place structures the pricing plans (ie, flat rate per mile or tiered rates), the business model becomes intriguing. If Better Place installs 85 battery swap stations and signs up 40,000 customers, they could be profitable, assuming they charge customers the equivalent of what \$5/gallon gasoline would cost. The model is highly dependent on the battery lifetime and miles driven by customers – there is substantial risk to Better Place if consumers drive less than anticipated.

Appendix: Alternative Solutions

Internal Combustion Engines Have Room to Improve

Over a longer time horizon, as battery costs come down and carmakers achieve more scale economies, electric vehicles will begin to make economic sense for consumers, prompting more meaningful adoption rates (especially if fuel prices are higher), allowing EVs to make a bigger dent on our petroleum tab; but in the meantime our US autos team believes that adoption rates will be too low to make a difference in global fuel consumption.

For example, if the penetration rate of EVs reaches, say, 2% of global vehicle sales by 2012, we estimate that the total reduction in fuel consumption could be in the neighborhood of 20.8 million barrels of petroleum per year. By contrast, if we assume that the remaining 98% of vehicles sold achieve a fuel economy improvement of 10% - through a combination of engine downsizing, turbocharging, and other existing technologies to make engines and transmissions more efficient - the total reduction in global fuel use would add up to an estimated 92.5 million barrels of petroleum per year.

If we look out further, say to 2020, by which time the fleet of ICE-powered vehicles will be achieving an average of 30% better fuel economy, we estimate improvements to traditional engines and transmissions will be delivering annual fuel savings on the order of 240 million barrels versus 2008 levels. For comparison, we estimate that the global penetration rate of EVs would have to reach 23% to match the fuel savings achieved by internal combustion engines. Our US autos team believes that a realistic assumption for EV penetration by 2020 is between 5% and 10% (vs. the economic model in this report forecasts 6.8% for PHEVs and EVs, combined, by 2020).

Don't forget about mix. The fuel economy of traditional vehicles - on average - will also improve as a result of changes in the mix of vehicles sold, a trend that has been in place for several years and which our autos team believes will continue. In other words, the fleet average fuel economy will improve as a result of more consumers choosing to buy smaller rather than larger vehicles. Just looking at the US market, for example, if we assume that the car/truck mix shifts by 5 percentage points over the next 5 years, from the current 53%/47% to 58%/42%, the fuel savings could add up to 7.6 million barrels per year (assuming the average car gets ~30mpg vs. the average truck at 25mpg, and assuming 15 million annual vehicle sales and 12,000 miles/year).

MPG-enhancing technologies exist today. On the following pages we discuss some of the technologies that our autos team believes will be the most widely deployed in the effort to meet new fuel economy standards in the US and globally. Foremost among these technologies will be engine downsizing (i.e., using a 4-cylinder instead of a 6-cylinder) accompanied by turbocharging (to deliver the same performance as the larger engine when needed). For a relatively modest development and component cost (ranging around \$120-\$690 per vehicle) automakers can achieve an average improvement in miles per gallon of 6.3%.

The table below lists various MPG-enhancing technologies along with their retail cost per vehicle and associated fuel consumption reduction, on a percentage basis. These cost and effectiveness estimates are based on 10 different vehicle classes, ranging from subcompact cars to large SUVs.

Exhibit 71: Potential Efficiency Measures

Technology	Retail Cost/Vehicle	Fuel Savings
Low friction lubricants	\$3	0.5%
Engine friction reduction	\$42-\$63	2.0%
VVT - intake cam phasing	\$59-\$119	1.0%
VVT - dual cam phasing	\$89-\$209	1.0%-3.0%
Cylinder deactivation	\$203	6.0%
Continuous VVLT	\$599-\$1,380	1.5%-3.5%
Camless valvetrain	\$505	2.5%
GDI - stoichiometric	\$271-\$377	1.5%
Gasoline HCCI Dual Mode	\$263-\$685	11.0%
Turbocharge & downsize	\$120-\$690	6.3%
Diesel - LNT	\$1,586	11.5%
Diesel - SCR	\$2,051	15.5%
6-speed automatic	\$132	1.5%
6-speed AMT	\$141	6.0%
6-speed manual	\$107	0.5%

Source: Company data, Credit Suisse estimates

Electric vehicles, on a per vehicle basis, offer the greatest potential for CO₂ reduction. When you normalize the reductions by the extra vehicle cost, however, one can see how applying current technologies is the most economic on a per-ton of displaced CO₂ basis. The following table suggests applying several of the technologies listed above will cost \$100 per ton of CO₂ reduction over the lifecycle of the vehicle (assumed to be 10 years). Electric vehicles, even if they receive a \$7,500 tax subsidy, will result in a net extra cost of \$205/ton, even if you assume all of the electricity comes from renewable resources (with zero emissions). From a public policy standpoint, if the goal is to reduce the absolute amount of CO₂ emissions, the most cost effective method is to apply small changes to existing technology. The are limits to the technologies, however, and if greenhouse gases were to be avoided entirely one would have to transition to an entirely electric fleet of vehicles.

Exhibit 72: Applying current technologies is the most economic way to reduce CO₂ emissions

	Current Vehicle (base)	Applying Current Technologies	Hybrid Electric Vehicles	EV, no subsidy	EV, with subsidy	EV with subsidy, all renewable generation
Base MPG	27 mpg	-	-	-	-	-
Efficiency Improvement	0%	21%	85%	-	-	-
New MPG	27 mpg	33 mpg	50 mpg	-	-	-
Incremental Cost per Vehicle	-	\$852	\$3,080	\$17,500	\$10,000	\$10,000
Total CO ₂ Emissions, per year	4,889 kg	4,040 kg	2,640 kg	3,000 kg	3,000 kg	0 kg
CO ₂ Reduction, per year	-	848 kg	2,249 kg	1,889 kg	1,889 kg	4,889 kg
Normalized Cost per Metric Ton CO₂	-	\$100	\$137	\$926	\$529	\$205
		<i>Least Expensive</i>				

Notes: Using Current US Generation fleet, near-term battery price (\$900/KWh), 20 KWh battery in EVs
Current Technologies include Dual Cam Phasing VVT (3% improvement for \$38), Downsizing and Turbo
Chargers (6% improvement for \$644), upgrade to 6-speed AMT (12% for \$170)

Source: Credit Suisse estimates

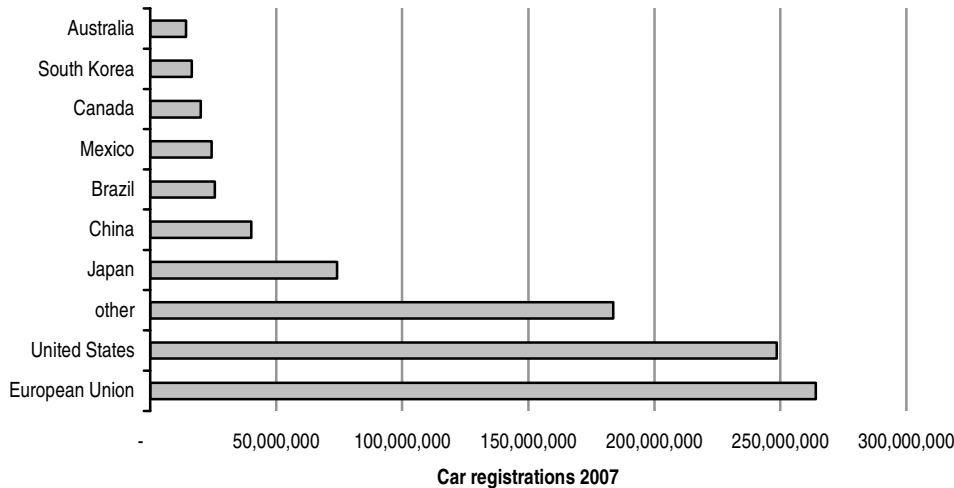
What does this mean for the future of electric vehicles? Auto manufacturers will address the need to meet CAFE standards with improvements to current internal combustion engine technologies and shifting the mix to smaller or lighter vehicles. Electric vehicles will be part of the puzzle, but not the driving force to reduce carbon emissions. Hence, we focus on the economics of electric vehicles to gauge potential adoption instead of the notion that governments will be forced to switch to electric vehicles to meet CAFE standards.

Fuel Economy Standards and regulations

As concerns grow about global warming and oil shortages, governments around the world are setting heightened fuel economy standards for vehicles to reduce their dependency on fossil fuels and the emission of greenhouse gases. As the gasoline prices have significantly declined in the last nine months, we believe legislation is necessary to

increase the energy efficiency in transportation as normal pricing mechanisms are no longer providing prudent signals to consumers. Automakers can meet the standards by developing advanced hybrid vehicles, improving internal combustion engines, reducing the weight of each vehicle, and by modifying power control systems.

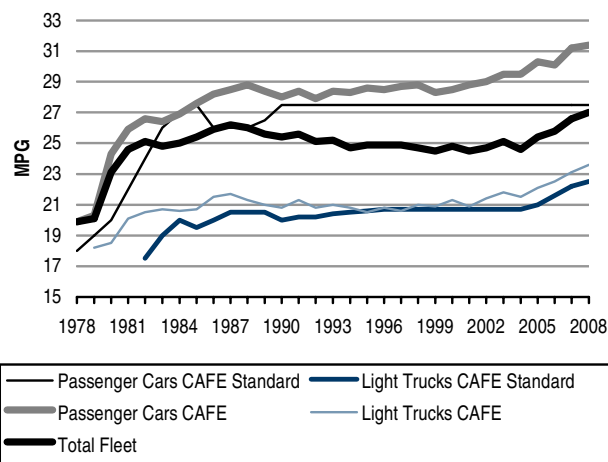
Exhibit 73: Global Car Registrations in 2007



Source: Company data, Credit Suisse estimates

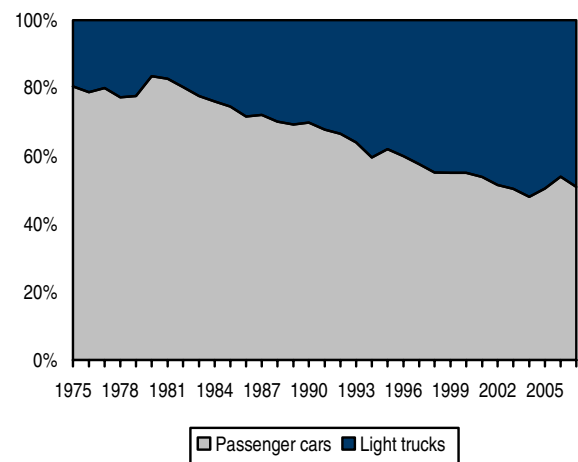
In the **United States** the congress has passed a bill saying new passenger cars and light trucks are due to reach a fuel efficiency standard of 35 mpg by the year 2020. The current CAFE regulation is 27.5 mpg for cars and 22.5 mpg for light trucks. The United States is mainly focusing on hybrid and plug-in hybrid vehicles to meet the standards by 2020. In May 2009, the White House unveiled a proposal to push CAFÉ standards to roughly 35.5 miles per gallon by 2015, four years ahead of the schedule.

Exhibit 74: CAFE vs. CAFE standard

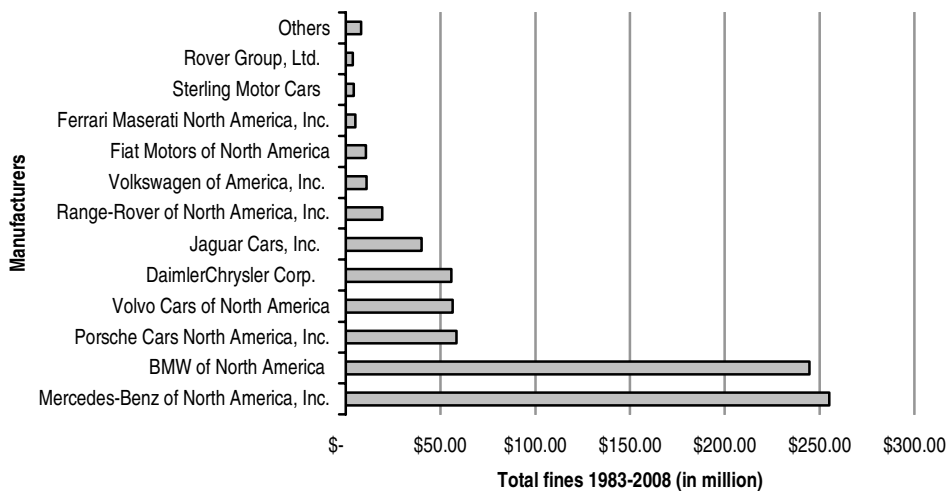


Source: Company data, Credit Suisse estimates

Exhibit 75: Passenger cars vs. Light trucks ratio



Source: Company data, Credit Suisse estimates

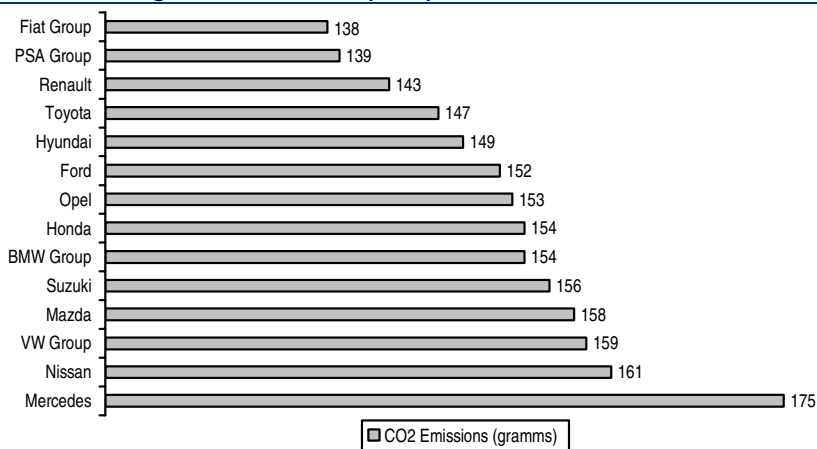
Exhibit 76: Summary of CAFE fines collected

Source: NHTSA, Company data, Credit Suisse estimates

The Obama administration is strongly focusing on reducing the CO₂ emission and the oil dependency on foreign countries by increasing the fuel efficiency in the road transport energy sector. Obama has signed two presidential memoranda in February 2009. One allowing states to raise emission standards above the national standard again. California and more than a dozen other states will likely take advantage of the permission. The second memorandum is the establishment of higher fuel efficiency standards for automakers. The President directed the Department of Transportation to set higher fuel efficiency standards, beginning with 2011 models.

California already enacted in 2002 the first state law requiring lower GHG emissions. The law forces to reduce GHG emissions from the full light duty vehicle fleet from 2004 baseline emission levels by 17 percent in 2020 and by 25 percent in 2030.

In December 2007 the **European Union** and an association of car makers have agreed to reduce the tailpipe emission to 120g/km by 2012. This equals a fuel efficiency of 48.9 mpg. In 2006 the average CO₂ emission of new car sales in the European Union was 160g/km and is projected to decline by only 5g instead of the targeted 20g. Therefore the European Commission announced the objective of 120g/km.

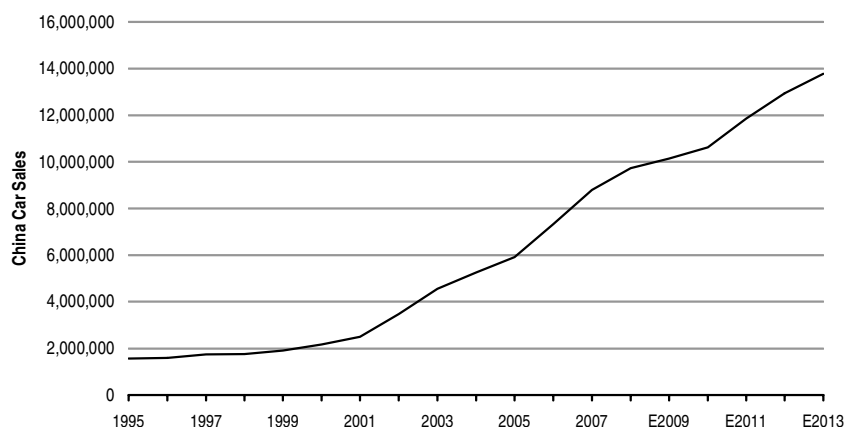
Exhibit 77: EU Average CO₂ Emissions (2008)

Source: Company data, Credit Suisse estimates

Japan's government has first established fuel economy standards for gasoline and diesel powered light-duty passenger and commercial vehicles in 1999. The targets are based on weight class. The latest standards dictate an average fuel efficiency goal of 46.9 mpg by 2015. Penalties are applied to carmakers if the targets are not met.

China has the most rapidly growing passenger car market. The next exhibit shows the car sales development in China including estimates to 2013. It shows clearly what an important role China will play in the auto and oil market in future and therefore the necessity of its concerns of setting fuel economy standards. The standards are very young in China and haven't been set for far in future. Its 2008 fuel economy standard was to reach an average of 36.7 mpg consumption limit by weight category.

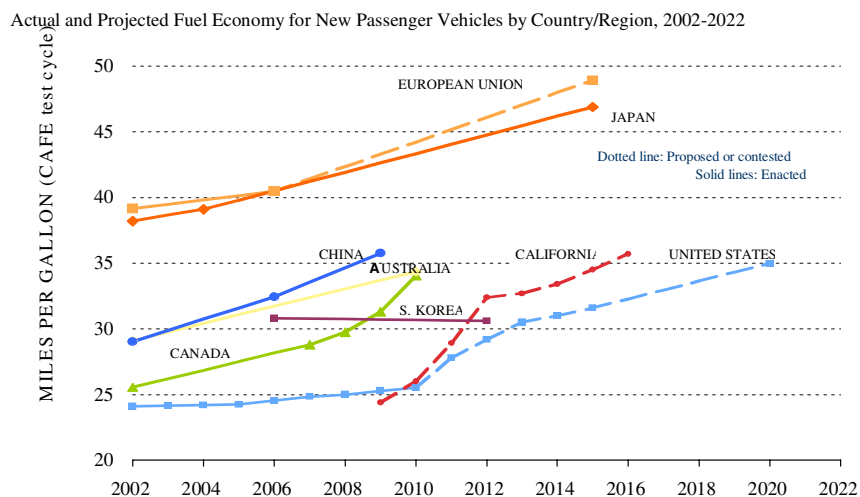
Exhibit 78: Car Sales in China



Source: Global Insight, Company data, Credit Suisse estimates

Canada introduced their CAFC (Company average fuel consumption) program in 1976 to track the fuel consumption of the new light duty vehicle fleet. The goals set by the program have historically been equivalent to the CAFE standards in the U.S. In October 2006 the Canadian government announced to reduce air pollutants and GHG emissions with additional measure beginning with the 2011 models. These new measures signaled the end of the CAFC standards.

Exhibit 79: Actual and Projected Fuel Economy for New Passenger Vehicles by country



Source: Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update,

ICCT, December 2008 update.

Source: The International Council on Clean Transportation,

Electric Vehicles will reduce CO₂ emissions

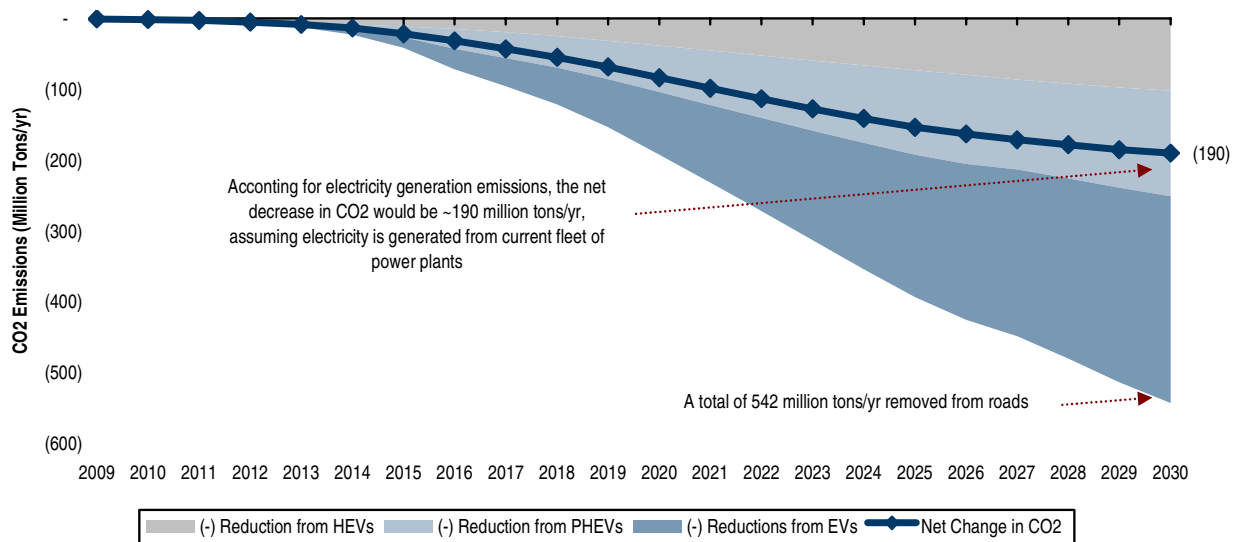
Will electric vehicles reduce carbon emissions, especially if the power is generated from the current fleet of power plants. If we assume the electric vehicles are purchased instead of efficient internal combustion engine vehicles (with efficiencies of 32 MPG), the *incremental* impact of HEVs, PHEVs and EVs is significant: CO₂ emissions would be reduced by 190 million tons per year, even if you generate electricity from the current power plants in each country. Every gallon of gasoline emits 19.4 pounds of CO₂ when burned. Excluding the impacts of generating electricity (or if it would come from renewables sources), emissions of CO₂ would be cut by nearly half a billion tons. To put things in perspective, the net reduction of 190 million tons is about 0.7% of current global emissions from all sources.

Exhibit 80: CO₂ Emission Reductions

Figures in millions of metric tons of CO₂ emissions per year

Country	2009	2010	2011	2012	2013	2014	2015	...	2020	...	2030
(-) Reduction from HEVs	(0.6)	(1.5)	(2.7)	(4.1)	(6.0)	(8.4)	(11.4)	...	(38)	...	(102)
(-) Reduction from PHEVs	(0.0)	(0.1)	(0.6)	(1.8)	(3.9)	(7.8)	(15.2)	...	(66)	...	(149)
(-) Reductions from EVs	(0.0)	(0.0)	(0.3)	(1.0)	(2.8)	(6.6)	(14.8)	...	(88)	...	(292)
(+) Generation Emissions	0	0	0	2	4	9	20	...	109	...	352
Net Change in CO₂	(0.6)	(1.6)	(3.1)	(5.3)	(8.6)	(13.7)	(21.8)	...	(84)	...	(190)

* Assumes 2006 generation mix



Source: Credit Suisse estimates

Other Ways to Increase Efficiency

Increasing fuel efficiency with variable power control systems

The consumption of electrical power in vehicles has a direct impact on the consumption of fuel and therefore on the CO₂ emissions. Reducing the consumption of electrical power in the car's power network by **100 W** is equal to a fuel efficiency improvement of **0.5 mpg**. There are several control applications which can be used to reduce the electrical power consumption. A study by Infineon in October 2008 shows that small changes can make a significantly contribution to reducing CO₂ emissions.

Variable PWM (Pulse Width Modulation) control of light bulbs

Although light bulbs in passenger vehicles are designed for 12 V, they mostly operate at the higher charging voltage of 14.4 V. This over voltage can increase the performance of all light bulbs from 200 W to 270 W. Assuming a day-to-night ratio of one-to-one (several countries require daytime running already) there is a 35 W power potential resulting in a 0.18 mpg saving potential.

Replacing light bulbs with LEDs

Today's modern LED lights produce more than 50 lumens/watt compared to less than 25 lumens/watt output by today's halogen and regular light bulbs. Car lighting currently requires about 200 W. An exchange to LED lighting would, again at a day-to-night ratio of one-to-one, result in a 50 W decrease, resulting in a 0.26 mpg increase.

Reducing the operating current of ECUs

A further potential to increase the mileage of vehicles is to reduce the standby current of Electronic Control Units (ECU). ECUs control one or more electrical systems or subsystems in a vehicle. Luxury vehicles with a large amount of electronic devices can contain up to 80 ECUs. The ECU of an entertainment system has a continuous current saving potential of 4A. The consumption can be enhanced by optimizing the resistor and circuit setup of the unit and by cutting current if the device is not immediately needed. 4A current saving equals 50 W, or 0.26 mpg.

PWM control of a fuel pump

Most vehicles have an electric fuel pump which is designed to deliver the maximum requirement to the combustion engine. Excess pump performance energy gets converted to waste heat. Installing a PWM to variably control the fuel pump can save 40% of its power consumption. The estimated cost of the device is \$28 and would pay itself after only 1.4 years, or 20,000 miles by saving 0.42 mpg.

Air conditioning fan with PWM

PWM controllers are standard for many air conditioning fans in vehicles. Nevertheless, there are still many fans on the market which convert between 80 and 130 W of power into waste heat. The additional cost of a PWM fan over an analog system is less than \$14, but results to a fuel efficiency increase of 0.42 mpg.

Alternator with active and low-loss rectification

Normal alternators are using diodes to rectify the voltages and produce approximately 1kW. By replacing these diodes with switching MOSFETs (metal-oxide-semiconductor field-effect transistor) and thus eliminate the diodes' forward loss, you can improve the effectiveness of the alternator by about 10%. The output power performance can, with an investment of about \$85, be increased by 100 W and reduce the fuel consumption by 0.5 mpg.

Electric Power Steering (EPS)

The hydraulic pump of the power steering module is powered directly by the combustion motors fan belt. While parking, when power steering is most used, the rpm of the vehicle is far lower than on the highway, when the power steering is least used. Most of the average 300 W power generated is converted into unusable heat power. By installing an electric pump energized by the vehicles battery the average power consumption could be reduced to 50 W. This results to an average power consumption of 250 W, respectively 1.3 mpg. After 1.3 years or 20,000 miles the investment of approximately \$ 85 would pay for itself.

Variable controlled electric water pump

By exchanging the engine-driven water pump with an electrically driven pump the efficiency of this the device can be strongly enhanced. Again the pump only runs when used and therefore makes a fuel consumption reduction of 1.5 mpg possible.

Exhibit 81: Payback calculation

Calculation with: 15,000 miles/year, \$2.03/gal, 32mpg efficiency

Application	CO2 Reduction (g CO2 / km)	Fuel Efficiency Increase (mpg)	Cost Increase (\$)	Payback Time (years)	Payback Time (years)	Payback Time (years)
PWM for bulbs	0.8	0.18	10	1.10	1.1	1.9
Use of LED	1.2	0.26	63	4.80	4.8	8.2
Entertainment	1.2	0.26	7	0.50	0.5	0.9
Fuel pump	1.9	0.42	28	1.40	1.3	2.3
HVAC Fan	1.9	0.42	14	0.70	0.7	1.1
Alternator	2.4	0.53	85	3.20	3.2	5.5
EPS	5.9	1.30	85	1.30	1.3	2.3
Water pump	7.1	1.56	77	1.00	1.0	1.7
	22.4	4.93	369		1.7	2.9

Source: Infineon report: Reducing CO₂ emission and achieving 2020 fuel efficiency requirements, Company data, Credit Suisse estimates

Based on the above estimates we can conclude that, by increasing the efficiency with the stated applications, the additional cost of \$369 can be paid back within 2.9 years.

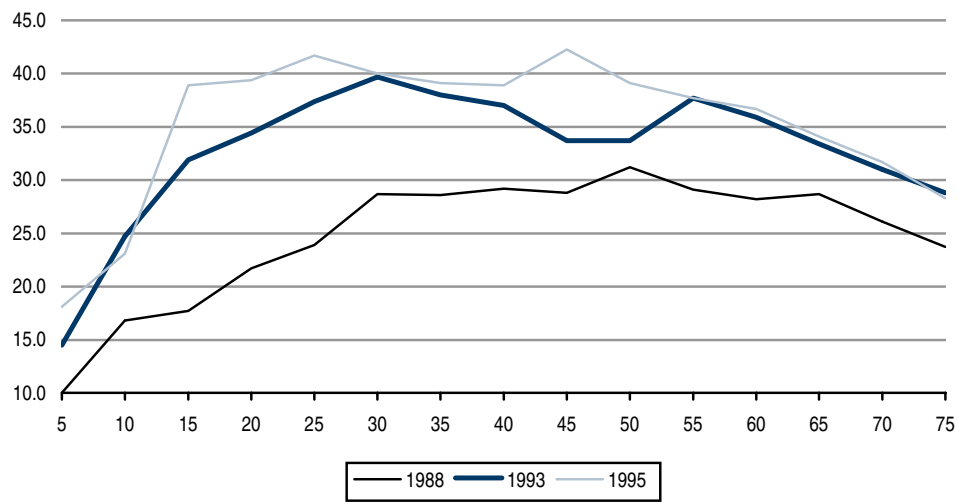
Simple ways to increase gas mileage

There are also many easy ways to increase or at least maintain your car's fuel efficiency without installing any applications or devices.

Driving with **under inflated tires** could increase the fuel consumption of the vehicle by up to 7% and lower the tire life by 10% for every 10% underinflation. For this reason the European Union Members of Parliament's Industry Committee has decided to introduce an energy, noise and wet grip measurement system for cars and trucks. This new tire-labeling systems, which is foreseen for introduction by 2012, will allow drivers to see how fuel efficient the tires are. A Belgian Member of European Parliament believes the fuel saving could equal taking 1.3 million cars off the road.

Eliminating 100 pounds of unnecessary **extra weight** in the car can increase the fuel efficiency by roughly 2%, depending on the vehicle.

The **driving speed** has an enormous impact on the fuel efficiency of a car. Increasing the highway cruising speed from 55mph to 75mph can raise the fuel consumption by over 20%. This fact has convinced Spain in 2008 to cut speed limits on highways outside major cities by 20%. Among European countries Spain has the highest dependency on fossil fuels and therefore hopes to reduce their oil imports by ~10% with this action.

Exhibit 82: Speed limit impacts fuel economy

Source: U.S. Department of Energy, Company data, Credit Suisse estimates

Appendix: Batteries not the only EV plays

The following is an excerpt from the report published by the Japan Technology and Materials team on October 1, 2009. The report is titled "Batteries not the only EV plays".

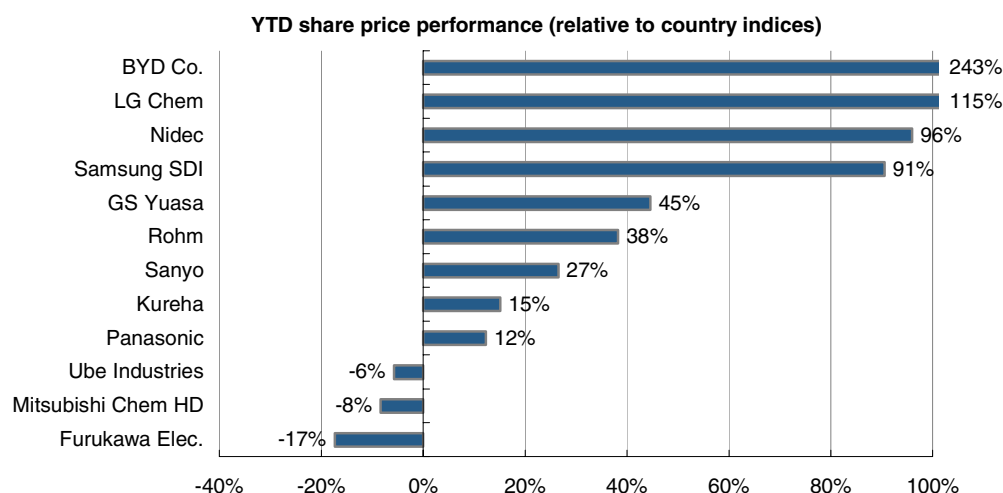
Jun Yamaguchi
813 4550 9789
jun.yamaguchi@credit-suisse.com

Investment stance, valuation

Batteries' (share prices) overheating

Share prices of eco-car-related stocks have enjoyed strong gains since last year on the back of the growing global interest in eco-cars. In particular, for firms in the eco-car supply chain, share prices of overseas battery makers have made notable gains, sharply outperforming their respective stock market indexes YTD. For example, BYD Co has outperformed by 243%, LG Chem by 115% and Samsung SDI by 91%. In Japan, Nidec, which produce motors, has outperformed the TOPIX by 96%, while battery makers GS Yuasa and Sanyo Electric have outperformed the benchmark by 45% and 27%, respectively, for these stocks to begin showing signs of overheating.

Figure 83: YTD relative share price performance



Note: Share prices as of 29 September

Source: Company data, Credit Suisse estimates

However, we note that the level of future expectation that can be priced into share prices, as well as the level of actual sales and earnings we can expect differs contingent on their position in the eco-car supply chain.

Materials, electronic components to offer a more promising earnings contribution than batteries

- **Lithium-ion battery (LiB) makers:** These firms will likely enjoy strong sales growth, but this market faces the toughest competitive environment and cost demands, with the risk of a frenzied business failing to generate profits. Not only that, the batteries themselves face a strong risk of becoming commoditized, despite claims by Japanese battery makers to the contrary.
- **LiB material makers:** The likely winners among LiB material makers are those firms that can fulfill criteria such as: (1) enjoying a technological lead (creates high entry barrier; stocks: Ube Industries, Kureha), (2) a dominant market share (Furukawa

Electric) and (3) provide one-stop supply of a wide range of materials (Mitsubishi Chemical HD).

- **Automotive electronic component makers:** We expect the growth of electronic components that automakers themselves are less likely to produce internally, to take off early. Specifically, power devices (Rohm) and mid-sized brushless motors (Nidec) come to mind, among others.
- **LiB production equipment makers:** This market boasts large potential, but limited benefit for firms as battery makers increasingly produce manufacturing facilities in-house, and an increasing number of firms enter the market as equipment becomes commoditized.

LiB makers

Given the brisk market expansion for various types of eco-cars, we look for automotive LiB supply-chain sales and volumes to expand quicker than expected. However, we believe that in the medium- to long-term, the profitability of automotive LiB will remain lower than current small LiB (for mobile phones, notebook [NB] PCs, etc). Japanese battery makers, in particular, face the risk of a frenzied business failing to generate profits. In addition, we are wary of batteries becoming commoditized sooner rather than later, despite claims often made by Japanese battery makers that “batteries are different from semiconductors and LCDs”. We take this cautious view for two reasons:

- (1) **Competition with overseas makers:** Severe direct competition with overseas LiB makers such as LG Chem and Samsung SDI, and battery/automaker BYD Co will intensify at an early stage in this market. Also, looking at the market participants, it is not difficult to envision batteries becoming commodities (as was the case with semiconductors and LCDs) after massive capex to gain capacity and cost competitiveness through scale.
- (2) **Focused business models:** On the cost front, overseas makers’ strength lies in the production of materials in-house. In terms of business model, most overseas makers choose either an independent route where they remain independent of automakers or form a tie-up with auto-parts makers. In contrast, many Japanese battery makers have formed tie-ups or joint ventures (JV) with automakers, making it difficult for battery makers to retain value-added in-house and increase profits.

LiB material makers

Battery material makers are much more likely to benefit from a growing market for eco-cars than battery makers. However, material makers also are not guaranteed the same level of lucrative profits they currently enjoy for small LiB materials. This is because we expect a greater number of new entrants to the market for auto-use LiB materials, and tough cost demands from automakers. We believe material makers need to possess at least one the following:

- (1) **Overwhelming technological lead (equates to high entry barrier)**
- (2) **Dominant market share**
- (3) **One-stop supply of wide range of materials**

Firms that look promising on this front are LiB anode-material maker Kureha and electrolyte/separator maker Ube Industries. Also, Mitsubishi Chemical HD, which produces all four primary materials used in LiB, should receive wide acclaim as a “total solutions provider” as automakers seek to develop LiB in-house. Furukawa Electric is the world’s largest producer of copper foil for small LiB, and we believe it should be able to replicate its lead in the auto field.

Automotive electronic component makers

A shift in power source of automobiles from the internal combustion engine to electricity presents a major change in the business landscape. The change in power train ensuing from the emergence of EV creates new markets for rechargeable batteries and vehicle drive motors (100kW level), as well as for power converter equipment (ie, inverters and converters) essential to drive motors. Also, engine-driven compressors and oil pumps becoming electrically-driven are also tailwinds.

Since batteries are the single most expensive component of an electric vehicle's production costs, this is likely to lead it to face the most intense cost pressure. On the other hand, we are particularly interested in the field of power devices (Rohm) and mid-sized brushless motors (Nidec). This is because electronic components makers can utilize their competitive advantages in these areas and there is limited risk of automakers producing them in-house.

LiB production equipment makers

If the market for auto-use LiB expands at a sharp pace, the market for production equipment is also likely to expand. However, the market trend seems to be to bringing the winding process (process of winding positive and negative poles, as well as separator into a core), the key process for improving productivity, in-house. Also, since multiple major battery makers (AESC, LG Chem) which are likely to command a high market share use laminate types, this equipment bears little relevance. Also, demand for power sources for charging equipment prior to battery shipment should increase in tandem with battery power capacity. However, as there is no significant technological differentiator between equipment, battery makers and heavy electrical machinery makers are likely to enter the market as demand increases, suggesting existing equipment makers will not enjoy business expansion on par with growth for the auto-use LiB market.

Figure 84: Eco-car-related business sales value forecasts (ie, batteries, materials and components)

Ticker	Company	Business domain	Eco car & battery-related business sales (mn\$)					CAGR		Ratio to total company sales		
			2009E	2010E	2011E	2015E	2020E	FY10-FY15	FY15-FY20	FY09E	FY10E	FY11E
6674	GS Yuasa	Batteries	51	133	226	1,198	1,912	55.3%	9.8%	2.0%	5.0%	7.9%
6752	Panasonic Corporation	Batteries	1,108	1,414	1,985	2,985	3,342	16.1%	2.3%	1.4%	1.5%	1.9%
6764	Sanyo Electric	Batteries	265	407	642	1,392	2,435	27.9%	11.8%	1.5%	2.2%	3.2%
3407	Asahi Kasei	Battery materials	273	305	347	399	504	5.6%	4.8%	1.9%	2.1%	2.3%
4023	Kureha	Battery materials	33	42	58	84	210	14.9%	20.1%	2.1%	2.5%	3.1%
4188	Mitsubishi Chemical HD	Battery materials	126	189	263	420	683	17.3%	10.2%	0.5%	0.7%	1.0%
4208	Ube Industries	Battery materials	147	179	242	368	630	15.5%	11.4%	2.5%	2.8%	3.5%
4217	Hitachi Chemical	Battery materials	126	142	158	210	315	8.2%	8.4%	2.8%	2.9%	3.1%
5801	Furukawa Electric	Battery materials	75	79	90	191	263	19.5%	6.6%	0.9%	0.9%	1.0%
6594	Nidec	Components	126	163	336	1,051	2,101	45.2%	14.9%	2.1%	2.5%	4.9%
6963	Rohm	Components	0	1	11	105	525	151.2%	38.0%	0.0%	0.0%	0.3%
051910.KS	LG Chem Ltd.	Batteries	14	34	110	1,412	4,242	110.7%	24.6%	0.1%	0.4%	1.2%
006400.KS	Samsung SDI	Batteries	0	0	0	941	3,181	n.a.	27.6%	0.0%	0.0%	n.a.
1211.HK	BYD Co Ltd	Batteries	403	484	566	981	1,624	15.2%	10.6%	7.1%	5.9%	5.7%

Note 1: JPN cos = FY, overseas cos = CY; Note 2: BYD sales include small LIBs; Note 3: Sanyo, Panasonic sales are auto LIB & auto NiMH

Source: Company data, Credit Suisse estimates

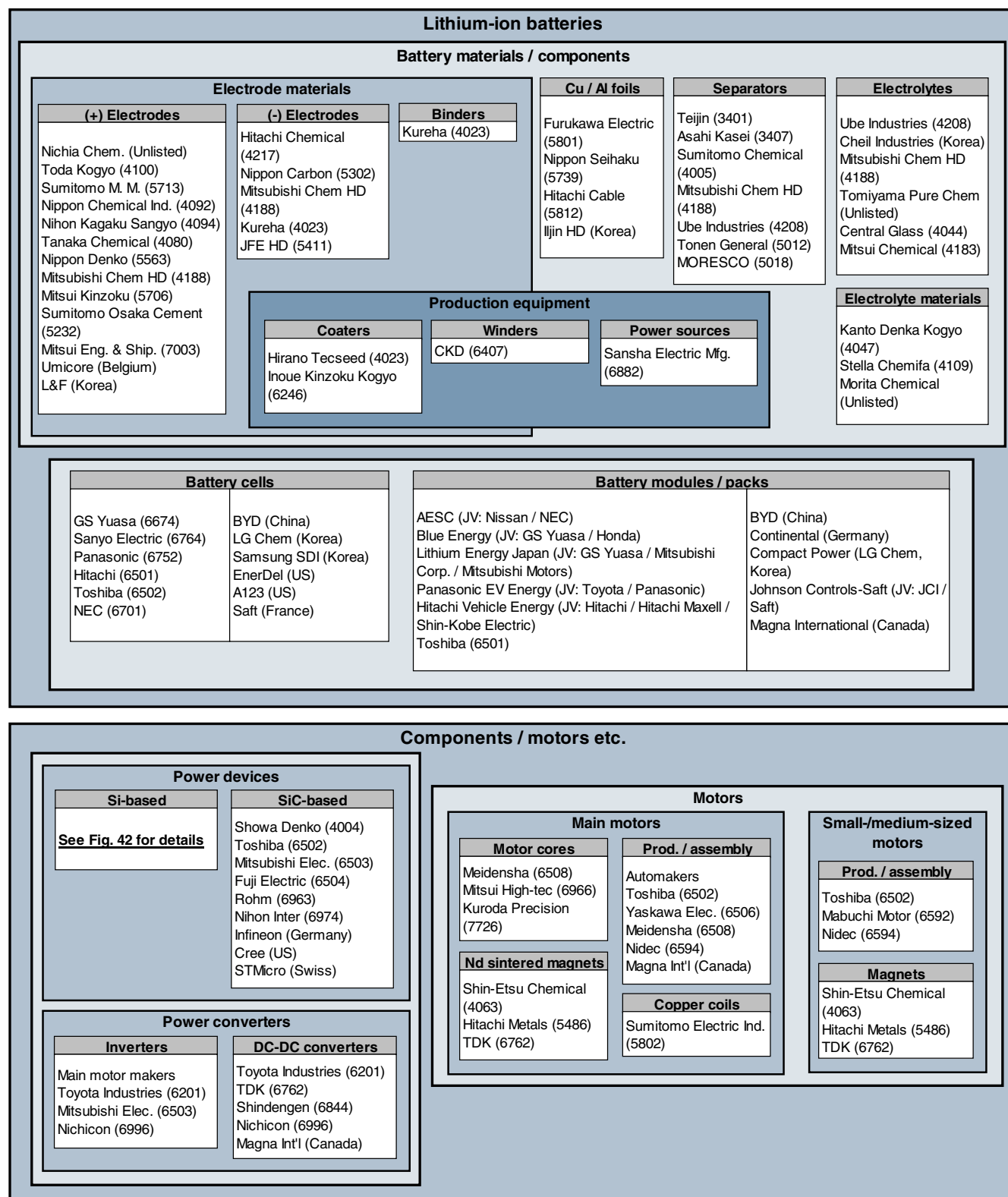
Figure 85: Valuations of companies with eco-car related businesses

Ticker	Company	Rating	Target Price	Current Price	Diff.	P/B (x)			EV/EBITDA (x)			P/E (x)			ROE (%)		
						F08 A	F09 E	F10 E	F08 A	F09 E	F10 E	F08 A	F09 E	F10 E	F08 A	F09 E	F10 E
<Battery makers>																	
6674	GS Yuasa	U/P	¥ 330	814	-59%	4.9	4.5	4.4	18.3	25.1	23.4	70.7	128.8	102.3	7.0%	3.5%	4.3%
6752	Panasonic	N	¥ 1,600	1,315	22%	1.0	1.0	0.9	8.1	8.8	4.0	n.a.	n.a.	16.5	-11.6%	-4.0%	5.8%
6764	Sanyo Electric	N	¥ 220	221	0%	n.a.	7.1	5.4	10.9	8.4	5.5	n.a.	n.a.	42.4	-41.0%	-2.6%	14.4%
<Chemical / material makers>																	
4023	Kureha	O/P	¥ 650	539	21%	1.0	1.0	1.0	6.8	6.7	5.4	29.0	28.4	16.7	3.5%	3.5%	5.7%
4188	Mitsubishi Chemical HD	N	¥ 460	379	21%	0.8	0.8	0.8	10.2	7.4	6.6	n.a.	n.a.	40.1	-10.0%	-2.2%	2.1%
4208	Ube Industries	O/P	¥ 360	245	47%	1.4	1.4	1.3	7.8	8.6	7.4	21.1	32.4	14.5	6.8%	4.3%	8.9%
5801	Furukawa Electric	N	¥ 390	373	5%	1.8	1.7	1.5	10.6	11.0	7.7	n.a.	119.1	14.3	-20.0%	1.5%	11.3%
<Automotive component makers>																	
6963	Rohm	O/P	¥ 7,400	6,350	17%	1.0	1.0	1.0	6.9	6.2	4.9	70.7	92.8	33.1	1.4%	1.1%	3.0%
6594	Nidec	O/P	¥ 8,500	7,090	20%	3.3	3.0	2.6	16.2	14.3	11.8	34.8	22.2	16.7	9.5%	13.3%	15.3%
<Global competitors>																	
006400.KS	Samsung SDI	U	W 127,000	149,000	-15%	1.5	1.5	-	9.6	10.1	-	35.7	36.0	-	4.1%	4.0%	-
051910.KS	LG Chem Ltd.	N	W 209,000	219,000	-5%	3.4	2.7	2.3	8.8	6.3	8.2	16.8	10.6	13.5	22.9%	28.1%	18.7%
1211.HK	BYD Co Ltd	O/P	HK\$ 59.00	63.55	-7%	9.8	8.4	6.9	62.5	32.0	20.2	127.6	66.5	38.4	7.7%	11.9%	18.0%

Note: share prices as of 29 September

Source: Company data, Credit Suisse estimates

Figure 86: Eco-car and LiB supply chain



Source: Company data, Credit Suisse estimates

Introducing our eco-car battery forecast model

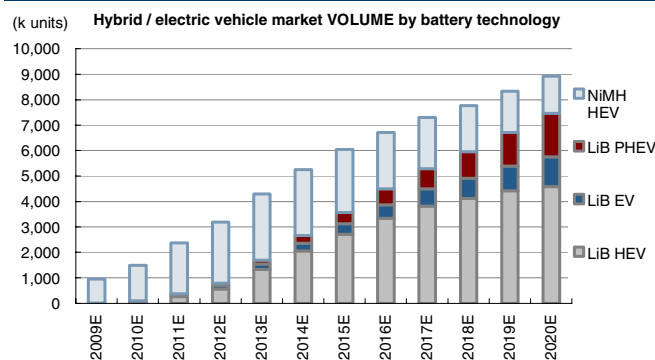
PHEV / EV acceleration to drive market growth

Below, we provide our projections for eco-car (HEV, PHEV, EV) demand as well as for sales (volume and value basis) of major LiB makers. We also include forecasts for extant NiMH batteries.

Summary

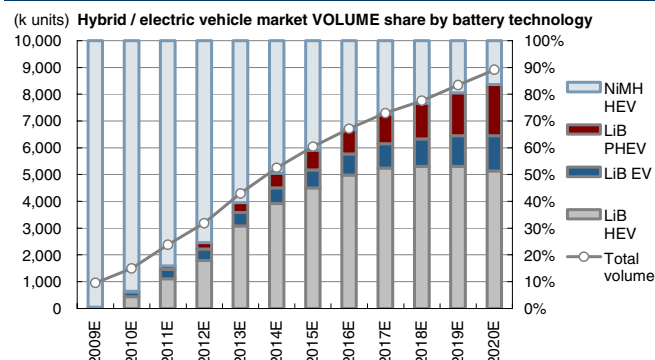
- **Forecast market for eco-car batteries will climb to ¥2.24tn (8.92mn units) in 2020:** We estimate this will break down as LiB-based ¥2.12tn (7.46mn units) and NiMH-based ¥122bn (1.46mn units). Moreover, LiB for EV and PHEV, which require batteries with a much larger capacity, will command 79% of the total market on a value basis. For battery capacity (LiB + NiMH), we estimate demand will grow from 6.1GWh in 2012 to 51.1GWh in 2020.
- **Initially those supplying LiB for EV and NiMH for HEV to have largest value-based share:** We forecast Automotive Energy Supply Corp (AESC) and Panasonic will lead the market, but estimate Japanese battery makers' share of the eco-car market will slide from just short of 80% in 2012 to less than 50% in 2020, for overseas makers to increase their share.
- **Real disparity to emerge among battery makers from 2013:** Key for battery makers will be whether they can secure orders to supply batteries for second-generation eco-cars and deliver to US/European eco-car makers. We also see independent battery makers coming into prominence.

Figure 87: Eco-car market forecasts by battery tech (vol)



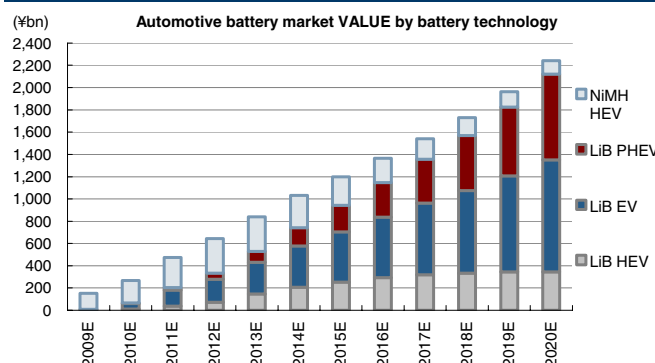
Source: Company data, Credit Suisse estimates

Figure 88: Eco-car market forecasts by battery tech (vol ratio)



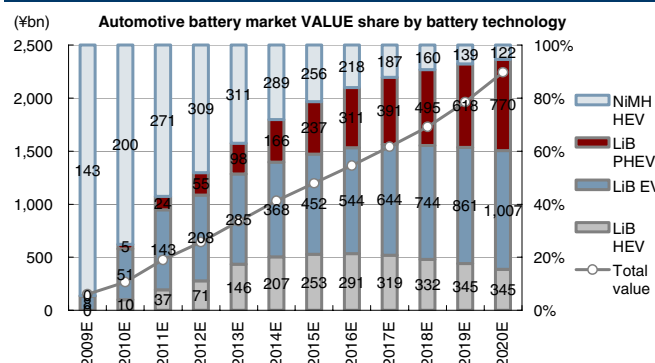
Source: Company data, Credit Suisse estimates

Figure 89: Eco-car battery forecasts (value; LiB+NiMH)

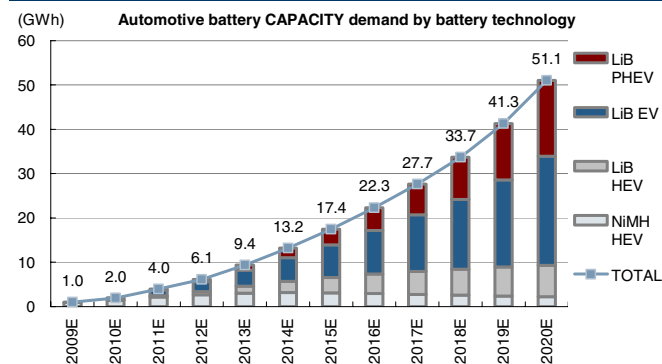


Source: Company data, Credit Suisse estimates

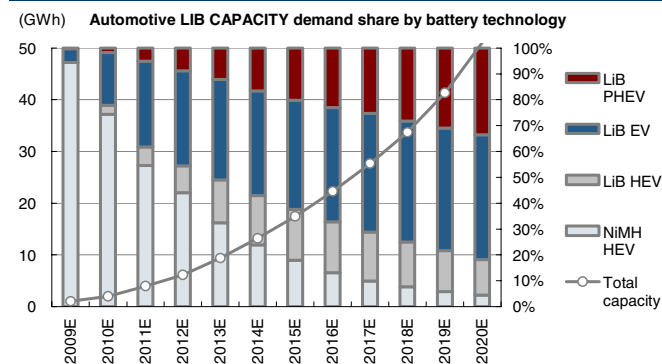
Figure 90: Eco-car battery forecasts (total value / ratio)



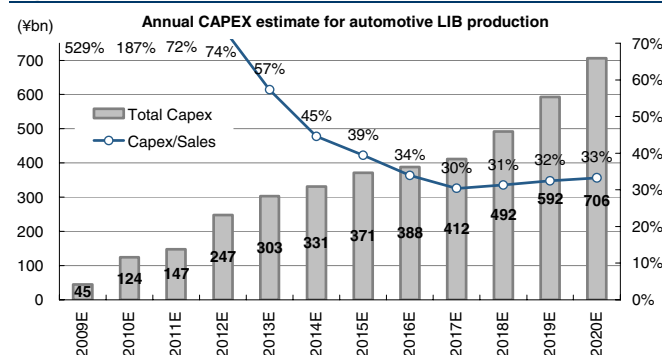
Source: Company data, Credit Suisse estimates

Figure 91: Eco-car battery capacity forecasts (by tech)

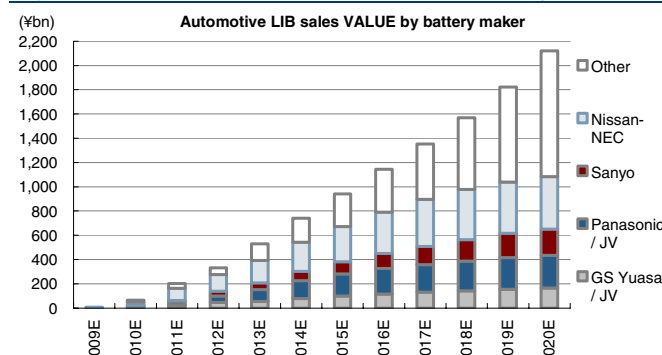
Source: Company data, Credit Suisse estimates

Figure 92: Eco-car battery capacity forecasts (ratio)

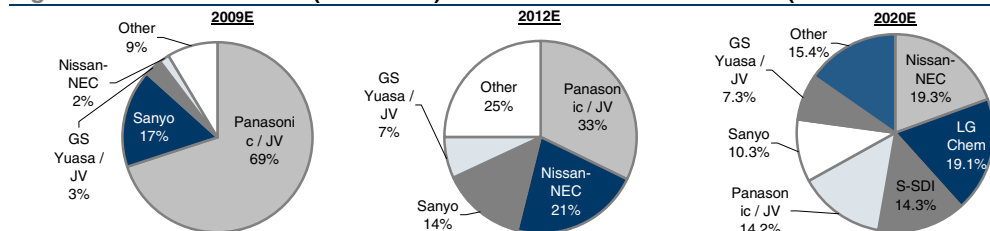
Source: Company data, Credit Suisse estimates

Figure 93: Automotive LiB capex value forecasts

Source: Company data, Credit Suisse estimates

Figure 94: Automotive LiB value share forecasts (by LiB maker)

Source: Company data, Credit Suisse estimates

Figure 95: Electric vehicle (LiB+NiMH) value market share forecasts (2009 / 2012 / 2020)

Source: Company data, Credit Suisse estimates

Forecast market for eco-car batteries will grow to ¥2.24tn (8.92mn units) by 2020

We estimate LiB will command ¥2.12tn (7.46mn units) of the ¥2.24tn market in 2020 and NiMH ¥122bn (1.46mn units).

By auto type (HEV, PHEV, EV) on a volume basis, we estimate HEV will account for 4.58mn units of LiB, PHEV 1.7mn units and EV 1.18mn units in 2020. On a NiMH base, we estimate HEV will total 1.46mn units, expecting full-fledged market expansion of LiB around 2012-13.

For LiB on a value basis, we estimate HEV will account for ¥345bn, PHEV ¥770bn and EV ¥1tn in 2020. For NiMH HEV, we estimate ¥122bn.

We expect NiMH batteries to peak in 2013-14 at 2.6mn units, to gradually shrink thereafter to 1.46mn units in 2020, and for LiB and NiMH to co-exist over a long period.

We estimate large-capacity LiB for EV and PHEV will account for 79% of the total eco-car battery market on a value basis in 2020. Moreover, we estimate battery-capacity demand (LiB + NiMH) will rise from 6.1GWh in 2012 to 51.1GWh in 2020.

Japanese makers to initially have the lead through high share of NiMH for HEV and LIB for EV, but share to shrink to less than 50% over medium to long term

By 2020, we estimate HEV will account for 68% of all eco-cars sold (of which LiB-based 51%, NiMH-based 16%), PHEV 19% and EV 13% on a volume basis. However, on a value basis, our estimates are HEV just 21% (LiB 15%, NiMH 5%), whereas PHEV 34% and EV 45%, for large capacity PHEV and EV to command the lion's share. This means battery maker share of sales (value base) will be swayed by the extent they can increase sales of PHEV and EV batteries rather than HEV batteries. Nearer-term, HEV batteries should still command over 50% value share until around 2013, with nearly 40% of this being NiMH-based. In these respects, we believe AESC (major customer Nissan) and Panasonic EV Energy (PEVE; major customer Toyota Motor) are likely to be the most potent during the initial phase of market expansion.

However, overseas battery makers (LG Chem, Samsung SDI, Johnson Controls-Saft, etc) are focusing efforts on winning orders for EV and PHEV, which will determine the long-term winners. Indeed, as overseas automakers seem to be initially pouring efforts into EV and PHEV development, if Japanese makers fail to capture a significant portion of battery orders for these vehicles, this is likely to lead to a drastic fall in market share for Japanese battery makers. We estimate Japanese battery makers' share of the eco-car market will slide from just short of 80% in 2012 to less than 50% in 2020, for overseas makers to increase their share.

Key factors for medium to long term are supplying second-generation eco-cars and making inroads into US and European automakers

Key to battery makers gaining a march on their rivals is to supply batteries for second-generation eco-cars as well as open up deliveries to US and European automakers. This should lead to a gap emerging between battery makers from 2013.

Supplier-customer relationships for eco-cars to be produced through to around 2012 look to be mostly decided already. Due to limited volumes and embryonic nature of the technology, most automakers are limiting supply to a single battery maker.

The market forerunners for eco-cars should begin releasing model changes by around 2013 while latecomers should begin commercial production. We expect order activity for battery makers taking place now are targeting these models. News flow such as the Nikkei reporting in August that Sanyo Electric will supply Toyota Motor with HEV batteries from 2011 is recently on the rise, and of particular interest will be trends of battery makers such as Sanyo Electric, Hitachi Vehicle Energy and Toshiba, which do not have JV relationships with automakers. Among overseas makers, we are still keenly interested in Samsung SDI, LG Chem and BYD Co, among others.

Figure 96: Eco-car, automotive battery long term forecasts

2009E2010E2011E2012E2013E2014E2015E2016E2017E2018E2019E2020E														CAGR '10-'20
Battery capacity per auto unit (assumption)														
(kWh / unit)	HEV	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.4	1.5	1.5	4.0%
	EV	16.0	16.0	16.0	16.5	17.0	17.5	18.0	18.5	19.1	19.7	20.3	20.9	2.7%
	PHEV	6.0	6.0	6.5	6.8	7.2	7.5	7.9	8.3	8.7	9.1	9.6	10.1	5.3%
	AVG.	7.7	7.7	7.9	8.1	8.4	8.7	9.1	9.4	9.7	10.1	10.5	10.8	3.5%
Battery cost per Wh (assumption)														
(¥ / Wh)	HEV	180	153	130	111	94	83	74	66	61	57	53	49	-10.8%
	EV	150	128	108	92	78	69	61	55	51	47	44	41	-10.8%
	PHEV	165	140	119	101	86	76	67	61	56	52	48	45	-10.8%
	AVG.	165	140	119	101	86	76	67	61	56	52	48	45	-10.8%
Battery cost per auto unit (assumption)														
(¥k)	HEV	180	159	141	124	110	101	93	87	83	81	78	75	-7.2%
	EV	2,400	2,040	1,734	1,518	1,329	1,205	1,104	1,024	970	929	890	853	-8.4%
	PHEV	990	842	775	692	617	570	533	504	487	475	464	453	-6.0%
	AVG.	1,190	1,014	883	778	685	625	577	538	513	495	477	460	-7.6%
CAPACITY demand by battery technology														
(MWh)	LiB HEV	0	68	284	642	1,550	2,505	3,437	4,397	5,235	5,859	6,542	7,047	59.0%
	LiB EV	53	400	1,318	2,256	3,642	5,343	7,370	9,853	12,688	15,748	19,600	24,647	51.0%
	LiB PHEV	3	33	202	539	1,132	2,193	3,506	5,116	7,003	9,523	12,789	17,129	86.9%
	NiMH HEV	950	1,456	2,163	2,700	3,042	3,163	3,125	2,925	2,738	2,563	2,399	2,245	4.4%
	(LiB+NiMH HEV)	950	1,524	2,447	3,341	4,591	5,668	6,562	7,322	7,973	8,422	8,941	9,292	19.8%
	(LiB total)	56	501	1,803	3,437	6,324	10,041	14,313	19,365	24,926	31,129	38,931	48,823	58.1%
	TOTAL	1,006	1,957	3,967	6,137	9,365	13,204	17,438	22,291	27,664	33,692	41,330	51,068	38.6%
Ratio	LiB HEV	0%	3%	7%	10%	17%	19%	20%	20%	19%	17%	16%	14%	-
	LiB EV	5%	20%	33%	37%	39%	40%	42%	44%	46%	47%	47%	48%	-
	LiB PHEV	0%	2%	5%	9%	12%	17%	20%	23%	25%	28%	31%	34%	-
	NiMH HEV	94%	74%	55%	44%	32%	24%	18%	13%	10%	8%	6%	4%	-
	(LiB+NiMH HEV)	94%	78%	62%	54%	49%	43%	38%	33%	29%	25%	22%	18%	-
	(LiB total)	6%	26%	45%	56%	68%	76%	82%	87%	90%	92%	94%	96%	-
Market VOLUME by battery technology (LiB+NiMH)														
(k units)	LiB HEV	0	66	262	570	1,325	2,059	2,716	3,341	3,825	4,116	4,420	4,578	52.9%
	LiB EV	3	25	82	137	215	306	409	531	664	800	967	1,181	47.0%
	LiB PHEV	1	6	31	79	158	292	444	617	804	1,041	1,332	1,699	77.4%
	NiMH HEV	950	1,400	2,000	2,400	2,600	2,600	2,470	2,223	2,001	1,801	1,621	1,459	0.4%
	(LiB+NiMH HEV)	950	1,466	2,262	2,970	3,925	4,659	5,186	5,564	5,826	5,917	6,040	6,036	15.2%
	(LiB total)	4	96	376	786	1,697	2,656	3,569	4,489	5,293	5,958	6,719	7,457	54.5%
	TOTAL	954	1,496	2,376	3,186	4,297	5,256	6,039	6,712	7,294	7,758	8,339	8,915	19.5%
Ratio	LiB HEV	0%	4%	11%	18%	31%	39%	45%	50%	52%	53%	53%	51%	-
	LiB EV	0%	2%	3%	4%	5%	6%	7%	8%	9%	10%	12%	13%	-
	LiB PHEV	0%	0%	1%	2%	4%	6%	7%	9%	11%	13%	16%	19%	-
	NiMH HEV	100%	94%	84%	75%	61%	49%	41%	33%	27%	23%	19%	16%	-
	(LiB+NiMH HEV)	100%	98%	95%	93%	91%	89%	86%	83%	80%	76%	72%	68%	-
	(LiB total)	0%	6%	16%	25%	39%	51%	59%	67%	73%	77%	81%	84%	-
Market VALUE by battery technology														
(¥bn)	LiB HEV	0	10	37	71	146	207	253	291	319	332	345	345	41.9%
	LiB EV	8	51	143	208	285	368	452	544	644	744	861	1,007	34.8%
	LiB PHEV	0	5	24	55	98	166	237	311	391	495	618	770	66.8%
	NiMH HEV	143	200	271	309	311	289	256	218	187	160	139	122	-4.8%
	(LiB+NiMH HEV)	143	210	308	380	457	496	508	510	506	492	484	467	8.3%
	(LiB total)	8	66	204	333	528	742	941	1,146	1,354	1,570	1,823	2,122	41.5%
	TOTAL	151	266	475	642	839	1,031	1,197	1,364	1,541	1,730	1,963	2,243	23.8%
Ratio	LiB HEV	0%	4%	8%	11%	17%	20%	21%	21%	21%	19%	18%	15%	-
	LiB EV	5%	19%	30%	32%	34%	36%	38%	40%	42%	43%	44%	45%	-
	LiB PHEV	0%	2%	5%	9%	12%	16%	20%	23%	25%	29%	31%	34%	-
	NiMH HEV	94%	75%	57%	48%	37%	28%	21%	16%	12%	9%	7%	5%	-
	(LiB+NiMH HEV)	94%	79%	65%	59%	54%	48%	42%	37%	33%	28%	25%	21%	-
	(LiB total)	6%	25%	43%	52%	63%	72%	79%	84%	88%	91%	93%	95%	-
Industry CAPEX (annual additional) for automotive LIBs														
(¥bn)	Total Capex	45	124	147	247	303	331	371	388	412	492	592	706	19.0%
	YoY	-	178%	19%	68%	22%	9%	12%	5%	6%	19%	20%	19%	-
(¥bn)	Capex/Sales	529%	187%	72%	74%	57%	45%	39%	34%	30%	31%	32%	33%	-
	Capex/MWh	100	95	90	86	81	77	74	70	66	63	60	57	-

Source: Company data, Credit Suisse estimates

Note: These estimates are using a bottoms-up model, which will differ from our top-down approach discussed earlier in the report.

Automotive LiB maker competitive landscape

Within the eco-car supply chain, we believe one of the most competitive areas is the field of LiBs.

There appear to be several differences between the business models of the Japanese and overseas battery makers.

(1) Japanese battery makers: JV relationships could pose a risk in limiting future profits

Risk to earnings outlook for minority-held JVs at the battery makers

AESC and PEVE are two automotive LiB makers expected to be among the largest in Japan. The majority holders of these companies are Nissan Motor and Toyota Motor, with stakes of 51% and 60%, respectively, while the battery technology is provided by the NEC Group and Panasonic, with minority stakes of 49% and 40%, respectively. However, when both of these JVs were initially set up, the battery makers held majority stakes. We believe the reason that control has passed to the auto makers is so that they can exert control of the direction of development work and ensure stable supply of LiBs, since shortages are expected in the early stages.

Since LiBs account for a high proportion of the cost of eco-cars, we believe they are trying to lower costs as much as possible. Thus, there seems to be little point in raising the profitability of the battery production companies as independent entities. We do not expect the profit contribution in real terms to the parent battery makers to keep pace with the projected increase in sales.

For the first generation of electric vehicles (models expected to be sold through around 2012), the auto makers' production plans already include decisions on where to source the batteries, and accordingly from the battery makers' viewpoint, there is little risk of a reduction in market share in the medium term. However, while JVs with the auto makers have the advantage of helping acquire customers in the near to medium term, over the longer term, any reduction in competitiveness or sales strength at the partner auto company could pose a risk that there will be delays in obtaining customers compared with other battery companies.

The only battery company that holds a majority stake in its battery production JVs is GS Yuasa, with a 51% stake in Lithium Energy Japan, against Mitsubishi Corp's stake of 34%, Mitsubishi Motors' 15% and a 51% stake in Blue Energy against Honda Motor's 49%. Over the medium to long term, reduction of production costs requires maintenance of a given market share, and to maintain, for example, a 10% global share in the LiB market by value will require an annual capital investment of around ¥30bn, in our estimates. However, we believe it will be difficult for the company to generate the necessary capital without an excessive deterioration of the parent balance sheet. There is also a possibility the auto makers could move to gain control of these JVs, as they did with Panasonic EV Energy and AESC. If that happens, then Yuasa's investment burden will be reduced, but there could also be constant pressure on margins.

Independent battery makers will face stiff competition from overseas makers in terms of cost and need to be able to differentiate themselves with solutions for automotive electronics

The independent battery makers (Sanyo Electric, Toshiba and the Hitachi Group, etc) will most likely have a very small share of battery sales for first generation electric vehicles (if at all), and their current development projects and marketing efforts are concentrating on supplying batteries to the next generation of vehicles. This means they will have to compete directly with the Asian and US/European battery makers (LG Chem, Samsung SDI, BYD and JCI-Saft, among others). Not only will these companies need to produce high-performance batteries, but they will also need to take orders in the face of stringent cost parameters at the auto companies. Also, if they do not provide many batteries for the

first generation of automobiles, then there is a risk they will fall behind in terms of mass production technology and accumulated cost reduction know-how.

However, we expect these makers not only produce batteries themselves, but also to offer solutions combining batteries with motors, control systems and other components, in an attempt to increase their appeal to the auto makers. We shall be watching this strategy with interest.

(2) Competition with overseas battery makers: Business model excludes JVs with auto makers

- **LG Chem (051910.KS):** Efforts to internalize key components for LiBs have been one of the key competitiveness points for LG Chem, in our view. For small LiBs, the company is currently relying for around 50% of cathode, 60% of electrolyte on in-house production. By leveraging its chemical background, the company's vertical integration strategy has helped in cost reduction, as products become more or less commoditized. LG Chem has been a relatively early mover – the company already supplies to Hyundai Motor Group (LPG hybrid cars), has announced plans to set up a JV with Hyundai Mobis and also signed a contract to supply LiBs to GM. (Page 16)
- **Samsung SDI (006400.KS):** SDI is currently the global number two player in small LiBs, with a volume market share of about 17%. Its OP margin jumped to about 18% in FY08 after many years of low profitability. This is attributed to economies of scale, stabilized yield, tighter cost control, currency support and increased competitiveness of its products vs. its competitors. After setting up a 50-50 JV with Bosch called SB LiMotive (SBLM) on September 2008, SDI at start-FY09 announced its new strategic focus on the green energy business (mainly, LiB for EV/HEV applications). Potential synergies from the tie-up looks to be positive (albeit still early), because of the JV's ability to offer the value-add in the form of flexible packs and systems versus those tied up with automakers. (Page 17)
- **BYD Co (1211.HK):** Originally a batteries and handset components maker, BYD has aggressively grown its auto business over the years and is now the company's largest division. We believe it will still take many years before the pure EVs account for a significant portion of BYD Auto's revenue. That said, BYD has over 6,000 R&D staff (5% of total workforce) and spends up to 5% of revenue on R&D efforts, much of which is directed towards EVs and battery technology development. BYD is in a unique position in that they have internalized an automaker and are gaining experience with auto production first-hand (which cannot be said of most battery makers), in addition to being able to better control pricing (and therefore profitability) for their own EVs. (Page 17)

(3) Individual battery company comments

GS Yuasa Corporation (6674, UNDERPERFORM, TP ¥330)

Expect FY15 automotive LiB sales of ¥100bn; hold majority stakes in battery production JVs, but over the medium to long term expect challenges in managing margins while simultaneously securing sufficient investment capital

Jun Yamaguchi
(Technology)

We expect sales of automotive LiBs at GS Yuasa to be ¥100bn in FY2015 (for a market share of 10.6% by value), rising to ¥164bn in FY20 (7.7%).

We believe the key point determining sales growth will be the extent to which Lithium Energy Japan can expand sales of its EV and PHEV batteries to other auto makers outside the Mitsubishi Motors group. Blue Energy (BEC) will commence production of batteries for Honda's HEVs from autumn 2010, but over the medium to long term, it is unclear whether the company will be able to keep its position as sole supplier to Honda.

If the automotive LiB market expands faster than expected, there is a strong possibility GS Yuasa's market share could fall. The main reason for this is that we believe a company of

Yuasa's size does not have sufficient capital resources to undertake the scale of capex needed to grow sales at the same pace as the market or faster. Even under current assumptions, we estimate around ¥30bn in capex would be annually from FY14, and we believe it will be difficult to undertake investment of this scale without damaging the company's balance sheet. Accordingly, we expect the company to have to choose one of two courses:

- (1) Retain its 51% share over the medium to long term, which will make a reduction in relative market share unavoidable, or
- (2) Reduce its capital participation below 50% and make the company into an equity-method affiliate, to reduce the burden from larger capex needed to realize larger scale merit and cost reduction potential.

Whichever course the company adopts, we expect a reduction in operating margins (with the best-case assumption looking for 5-10%). Accordingly, we believe it will take around 10 years before the company starts to generate positive free cash flows (FCF) in the automotive LiB business (assuming GS Yuasa retains its 51% stake). For this reason, we believe the company will have to come up with some new measures to support margins in this business.

Figure 97: GS Yuasa (6674) – automotive LiB business; needs over 10 years to turn cash flow positive independently

Automotive LiB business value (¥mn)													Term. val.
(¥mn)	FY3/10	FY3/11	FY3/12	FY3/13	FY3/14	FY3/15	FY3/16	FY3/17	FY3/18	FY3/19	FY3/20	FY3/21	
Sales	4,868	12,322	23,819	38,869	55,181	78,323	99,744	116,014	130,477	142,348	155,086	164,252	
Operating profit (a)	-2,000	-3,500	-3,000	-1,000	0	1,175	2,992	5,221	7,829	9,964	12,407	14,783	
OPM (%)	-41.1%	-28.4%	-12.6%	-2.6%	0.0%	1.5%	3.0%	4.5%	6.0%	7.0%	8.0%	9.0%	
Income tax (b)	0	0	0	0	0	470	1,197	2,088	3,131	3,986	4,963	5,913	
Depreciation (c)	5,085	5,621	9,507	12,865	22,781	25,271	23,430	22,272	20,374	22,690	20,573	22,450	
Op. CF (d) [(a)-(b)+(c)]	3,085	2,121	6,507	11,865	22,781	25,976	25,225	25,404	25,071	28,669	28,017	31,320	
CAPEX (f)	15,000	9,500	15,500	18,500	32,544	35,845	32,999	31,149	28,298	31,297	28,183	30,544	
Capex / sales ratio (%)	308%	77%	65%	48%	59%	46%	33%	27%	22%	22%	18%	19%	
FCF [(d)-(e)-(f)]	-11,915	-7,379	-8,993	-6,635	-9,763	-9,869	-7,774	-5,745	-3,226	-2,628	-165	775	45,181
Discounted Cash Flow	-11,156	-6,469	-7,382	-5,099	-7,026	-6,650	-4,905	-3,394	-1,784	-1,361	-80	352	20,512
Perpetual growth rate:												5.0%	

Enterprise Value: -34,442

Source: Company data, Credit Suisse estimates

Figure 98: Comparison of battery makers' finances

(mn USD)									
Ticker	Company		Cash	Debt	NET DEBT	Shareholder equity	Total assets	Net D/E	Equity ratio
6674	GS Yuasa	Japan	108	877	770	631	2,162	122%	29%
6752	Panasonic	Japan	12,895	8,968	-3,927	28,856	69,456	-14%	42%
6764	Sanyo Electric	Japan	3,327	6,235	2,908	1,451	15,220	200%	10%
6501	Hitachi	Japan	5,967	29,102	23,135	10,691	94,658	216%	11%
6502	Toshiba	Japan	3,470	15,047	11,577	11,293	56,816	103%	20%
6701	NEC	Japan	2,808	9,281	6,473	6,554	30,313	99%	22%
051910.KS	LG Chem	Korea	633	1,689	1,056	3,740	7,042	28%	53%
006400.KS	Samsung SDI	Korea	928	638	-290	3,768	5,141	-8%	73%
1211.HK	BYD	China	301	1,021	720	1,823	4,852	40%	38%
JCI	Johnson Controls	US	543	4,778	4,235	8,227	22,466	51%	37%

Note: Financials as of end-June / converted to USD

Source: Company data, Credit Suisse estimates

Panasonic (6752, NEUTRAL, ¥1,600)**Panasonic EV Energy: expectations of steady growth on supply of LiBs to Toyota**Koya Tabata
(Consumer electronics)

Panasonic EV Energy (PEVE) is a 60-40 JV between Toyota and Panasonic, which currently produces NiMH batteries for hybrids. Production capacity was 500,000 units in 2008 and 700,000 in 2009, and at end-2009, we expect it to reach 800,000 units. Including the Miyagi line, the company aims to be able to make around 1mn units per year by as early as 2010.

We expect the scale of sales to be around ¥100.0bn from 2010. By around 2014, we expect the market for NiMH batteries to grow from the current less than 1mn to around 2.6mn per year, and expect PEVE to maintain the leading market share.

In the area of automotive LiB, we expect PEVE to mainly supply its parent, Toyota Motor, but currently production capacity is very low.

The reason demand for NiMH batteries is currently higher than for LiB is that total costs, including control circuits, are lower, and since there is a large quantity of past data, these batteries have a good safety record.

Panasonic is cooperating on R&D and mass production technology for PEVE applications.

We expect PEVE's sales of automotive LiB to expand to ¥26.5bn in 2011, ¥97.1bn in 2013, ¥183.6bn in 2015 and ¥270.0bn in 2020. In terms of profits, we believe margins on LiB will be similar to those on NiMH batteries in the early stages – when high levels of capex and R&D expenses pushed down earnings.

We believe customers for the LiB business will depend heavily on strategy at parent Toyota Motor.

Sanyo Electric (6764, NEUTRAL, ¥220)**Expect a steady expansion in cash flow as a specialist battery maker**Koya Tabata
(Consumer electronics)

Sanyo Electric is now at the stage where we expect it to increase investment in HEV batteries in response to the increase in demand for HEVs. In terms of the production capacity of NiMH battery cells, capacity should increase from 1mn cells per month in FY08 to 3.5mn cells per month by end-FY09, an increase of 3.5x. Initially, we expected around 2.5mn per month, but now expansion is to be upped by 1mn cells per month. We expect the total scale of investment to be several billion yen. Demand from Honda and Ford Motor is improving.

The main differences with the company's competitors are: (1) the company is maintaining its competitiveness while generating steady cash flows in the consumer LiB business, (2) the HEV NiMH battery business has finally started to generate profits and (3) the company aims to commence production of automotive LiB at its Tokushima plant within the year. From the cash-flow viewpoint, we expect the same kind of start-up costs for the automotive LiB business as for other companies within the industry, but with its consumer lithium ion battery and HEV NiMH battery businesses, the battery business as a whole should be able to generate sustainable positive cash flows.

The main concern now is the possibility of a reduction in market share. In the period when NiMH batteries were the main type of battery for automobiles, VW, Ford, Honda and Toyota were the major customers, but these companies have strengthened their joint development projects with rival battery makers both in Japan and abroad, and uncertainty remains whether the company will be able to leverage its strengths as an independent battery maker as the change to LiB progresses.

However, we expect sales of automotive LiB to expand to ¥215.8bn by 2020, and shall be concentrating on margins in this area in the future.

Figure 99: Sanyo Electric (6764): battery business forecasts

Sales of main products (¥mn)	FY3/07	FY3/08	FY3/09	CSE FY3/10	CSE FY3/11	CSE FY3/12
Total battery sales (rechargeable+PV+other)	414,404	488,434	470,357	440,226	499,399	565,314
YoY		17.9%	-3.7%	-6.4%	13.4%	13.2%
Rechargeable batteries	296,916	366,173	342,761	309,195	346,995	387,587
YoY		23.3%	-6.4%	-9.8%	12.2%	11.7%
of which, Li-ion		256,066	263,300	250,135	291,824	335,598
YoY			2.8%	-5.0%	16.7%	15.0%
of which, Ni-Cd		62,000	43,800	30,660	26,061	22,152
YoY			-29.4%	-30.0%	-15.0%	-15.0%
of which, Ni-MH (ex. Automotive)		48,107	35,700	28,400	29,110	29,838
YoY			-25.8%	-20.4%	2.5%	2.5%
Solar battery	61,169	72,714	81,168	81,496	93,138	99,348
YoY		18.9%	11.6%	0.4%	14.3%	6.7%
Battery - other (primary, automotive etc.)	56,319	49,547	46,428	49,535	59,265	78,379
YoY		-12.0%	-6.3%	6.7%	19.6%	32.3%

Source: Company data, Credit Suisse estimates

LG Chem (051910.KS, NEUTRAL, TP W209,000)

LG Chemical started off its business since early 2000, and expanded to a combined capacity of 60mn cell/month in Korea and China. The rechargeable batteries business currently contributes to around 10% of top line and around 8% of 2009 bottom line earnings. The company started the business since early 2000 and a bumpy performance from significant operating loss to recently mid-teen OP margin as the battery industry was oversupplied, the company had a product recall and lacked economies of scale.

Effort to internalize key components: This has been one of the keys to competitiveness, in our view. For the batteries for handsets/NB PCs, the company is currently relying for around 50% of cathode, 60% of electrolyte on in-house production. As well, the company has been developing its own cathode that uses less cobalt but more manganese, which is cheaper than cobalt. As such, leveraging its chemical background, the company's vertical integration strategy has helped in cost reduction, as products become more or less commoditized.

Battery for hybrid cars: The company should be able to leverage on the batteries, given its relatively good track record in the smaller LiBs (for handsets and NB PCs). LG Chem has been a relatively early mover – currently, the company is supplying to Hyundai Motor Group for its LPG hybrid cars. LG Chem also announced plans to set up a JV with Hyundai Mobis, the module maker within Hyundai Motor Group. The company signed a contract to supply batteries to GM's Chevy Volt and Buick, starting from end-2010 to end-2015. In August, various media reported that LG Chem would build a plant in Michigan. By deciding to do so, LG benefits from the US government's grant of \$151mn, and a \$130mn of tax credit from the state of Michigan.

As per the company's official disclosure, it aims for W2tn (around \$1.7bn) revenue from the business or 20% market share by 2015, by adding more contracts to supply LiBs. It announced a capex plan of W1tn (\$850mn) by 2013. Given the premature stage of the business, the plan should be a moving target – the need to secure more volume to meet their target. Based on our estimates, top-line earnings contribution from the batteries for HEV/PHEV (not including the batteries for handsets/NB PCs) is not likely to exceed 10% of the company total by 2015.

Samsung SDI (006400.KS, UNDERPERFORM, TP W127,000)

Since its first commercial production of rechargeable batteries in FY00, SDI posted a stellar volume growth (eg, from a mere 2.7mn units in FY00 to close to 500 mn units in FY08, becoming a global number two player with a volume market share of about 17%). Despite the strong volume growth as such, its related profitability stayed quite marginal, at the low single digits, at best, until FY08 when SDI posted an OP margin of about 18%. The company attributed the sharp turnaround to economies of scale, stabilized yield, tighter cost controls, the currency support and troubles at its competitors (which particularly

A-Hyung Cho
(Korea research)

John Sung
(Korea research)

shows the competitiveness of its products vs its competitors). SDI is forecast to post a low-teen OP margin on its rechargeable battery business in FY09.

After setting up a 50-50 JV with Bosch (a leading auto components and integration provider) called SB LiMotive (SBLM) in September 2008, SDI at start-FY09 announced its new strategic focus on the green energy business (mainly, LiB for EV/HEV applications). The company painted a very aggressive target for this new business (eg, capturing 30% of the EV/HEV battery market by 2015). We previously commented that clarifications on its next strategic focus are certainly positive for SDI, after the doldrums in the previous few years. Moreover, albeit still early, potential synergy from the tie-up looks to be positive, because of the JV's ability to offer the value-add in the form of flexible packs and systems versus those tied up with automakers.

Since then, there has been a series of announcements on strategic alliances with others. On July 14, SBLM announced that it is acquiring 100% stake at Cobasys in the US, which has hybrid energy storage and pack technologies. On 3 August, SBLM announced its EV/HEV battery supply contract with BMW of Germany from 2013 to 2020. Still today, local media (such as the Maeil Economic Daily) continues to report possible additional tie-ups for SBLM with other automobile makers as well.

Still, however, related earnings outlook for the JV looks unclear, partly because of the long-term nature of the business and also lack of clear guidance from the unlisted JV. At the moment, the only publicly articulated guidance is its capex plan (eg, a total of W500bn in the next five years). Our preliminary estimate of the potential value contribution for SDI from the EV/HEV battery JV with Bosch suggests about W22,000 per share. We remain cautious on the stock, with an UNDERPERFORM rating and W127,000 TP, mainly given the weak ROE profile of its core earnings in the next few years.

BYD Co Ltd (1211.HK, OUTPERFORM, TP HK\$59.00): from underdog to an aggressive Cerberus

BYD, originally a batteries and handset components maker, entered the automobile business in 2003 through the acquisition of XQC (not listed). Since then, the company has been dubbed the underdog of the Chinese automobile industry, given its lack of experience and scale.

BYD's auto business has grown aggressively over the years and is now the company's largest division, contributing up to 55% of total revenue and 80% of profit. With about 4% market share (in volume terms), BYD is one of the most successful and leading automakers in China. With over 6,000 R&D staff (5% of total workforce), the company spends up to 5% of revenue on R&D efforts, which could amount to Rmb1.9 bn in 2009, based on our forecasts. Most of the R&D are directed toward the auto division, especially on the pure electric vehicles while a significant portion would also be used on the development of solar and wind power storage technology.

We forecast the company to produce up to 648,000 vehicles in 2010 (with a total capacity of 1mn vehicles), however, even with its long history involving LiBs, we estimate its PHEVs (F3DM and F6DM) and EVs (e6 and eBus) to account for a mere 4% of BYD's auto sales. Even with the help of MidAmerican Energy's help to launch BYD's new energy vehicles in the US, we do not see any meaningful contributions from this category of cars given: (1) the lack of infrastructure in place, and; (2) it takes time for consumers to fully accept the PHEV and EV concepts.

In our view, we believe it will take another five years for the pure electric vehicles to account for over 10% of BYD Auto's revenue (27% if including hybrids). It is worth noting that BYD has recently signed a deal to supply LiBs to Shanghai Auto for their own version of hybrids.

The long-term success of the BYD's new energy vehicles will require the support of the governments by erecting charging stations as well as introducing policies and incentives to encourage the consumers in purchasing these breed of vehicles. That said, BYD is in a

Adrian Chan
(Hong Kong research)

unique position in that it has internalized an automaker and is gaining experience with auto production first-hand (which cannot be said of most battery makers), in addition to being able to better control pricing (and therefore profitability) for its own electric vehicles.

Figure 100: Automotive LIB sales forecasts by battery maker

LIB forecasts by maker		2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E	2019E	2020E
GS Yuasa	Battery vol. (k)	2.0	12.3	57.9	119.1	185	300	384	451	492	513	536	541
	YoY		505%	372%	106%	55%	62%	28%	18%	9%	4%	4%	1%
	Revenues (¥bn)	4.9	12.7	25.2	45.9	55.2	78.3	99.7	116.0	130.5	142.3	155.1	164.3
	YoY		161%	98%	82%	20%	42%	27%	16%	12%	9%	9%	6%
	Volume (MWh)	32	98	222	474	661	1,061	1,524	1,973	2,419	2,846	3,342	3,813
Panasonic	Battery vol. (k)	0.5	18.1	69.0	154.4	335	585	769	925	1,019	1,086	1,151	1,171
	YoY			281%	124%	117%	75%	31%	20%	10%	7%	6%	2%
	Revenues (¥bn)	0.5	6.3	26.5	53.4	97.1	147.1	183.6	210.0	227.5	245.2	261.0	270.2
	YoY			321%	102%	82%	51%	25%	14%	8%	8%	6%	4%
	Volume (MWh)	3	44	227	539	1,150	1,963	2,750	3,493	4,110	4,761	5,448	6,069
Sanyo	Battery vol. (k)	0.0	7.6	21.4	72.9	179	307	433	575	710	823	941	1,027
	YoY			183%	241%	146%	71%	41%	33%	24%	16%	14%	9%
	Revenues (¥bn)	0.0	3.1	11.0	39.8	54.0	77.7	99.0	123.5	151.1	176.2	199.3	215.8
	YoY			256%	262%	36%	44%	27%	25%	22%	17%	13%	8%
	Volume (MWh)	0	23	98	418	649	1,043	1,485	2,053	2,729	3,427	4,171	4,860
AESC	Battery vol. (k)	1.0	24.9	105.9	201.7	330	443	582	723	812	861	919	982
	YoY			325%	90%	63%	34%	31%	24%	12%	6%	7%	7%
	Revenues (¥bn)	2.4	26.2	99.1	137.6	187.8	241.1	291.2	342.6	388.8	413.5	423.3	433.7
	YoY		990%	279%	39%	36%	28%	21%	18%	13%	6%	2%	2%
	Volume (MWh)	16	202	903	1,464	2,341	3,416	4,632	6,050	7,470	8,543	9,389	10,325
Other	Battery vol. (k)	0.3	33.2	121.4	238.3	668	1,021	1,401	1,815	2,261	2,675	3,172	3,736
	YoY			266%	96%	180%	53%	37%	30%	25%	18%	19%	18%
	Revenues (¥bn)	0.7	17.8	42.0	56.8	134.2	197.3	267.9	353.4	456.6	593.1	784.7	1,037.7
	YoY			136%	35%	136%	47%	36%	32%	29%	30%	32%	32%
	Volume (MWh)	4	134	354	542	1,522	2,557	3,923	5,796	8,198	11,552	16,581	23,756
TOTAL	Units (k)	3.8	96.1	375.7	786.4	1,697	2,656	3,569	4,489	5,293	5,958	6,719	7,457
	Revenues (¥bn)	8.4	66.1	204	333	528	742	941	1,146	1,354	1,570	1,823	2,122
	Volume (MWh)	56	501	1,803	3,437	6,324	10,041	14,313	19,365	24,926	31,129	38,931	48,823
	Capex/year (¥bn)	45	124	147	247	303	331	371	388	412	492	592	706
	Capex (¥bn)/MWh	100	95	90	86	81	77	74	70	66	63	60	57
	Capex/sales (%)	529%	187%	72%	74%	57%	45%	39%	34%	30%	31%	32%	33%
Revenue share (%)	GS Yuasa	58%	19%	12%	14%	10%	11%	11%	10%	10%	9.1%	8.5%	7.7%
	Panasonic	6%	10%	13%	16%	18%	20%	19%	18%	17%	16%	14%	13%
	Sanyo	0%	5%	5%	12%	10%	10%	11%	11%	11%	11%	11%	10%
	AESC	29%	40%	49%	41%	36%	33%	31%	30%	29%	26%	23%	20%
	Other	8%	27%	21%	17%	25%	27%	28%	31%	34%	38%	43%	49%

Source: Company data, Credit Suisse estimates

Note: These estimates are using a bottoms-up model, which will differ from our top-down approach discussed earlier in the report.

Figure 101: Manufacturer relationships for automotive LiBs

Business Format	Auto maker customer (plan)	Battery cell / system supplier	Investor / investment ratio	Remarks
<u>Auto maker + Battery maker JV</u>	Toyota	Panasonic EV Energy	Toyota (60%), Panasonic (40%)	Currently supplies Ni-MH; will also supply Li-ion in the future
	Nissan	Automotive Energy Supply (AESC)	Nissan (51%), NEC (42%), NEC Tokin (7%)	AESC will supply battery packs, and NEC Tokin will supply electrodes to AESC
	Fuji Heavy Industries			
	Mitsubishi Motors	Lithium Energy Japan	GS Yuasa (51%), Mitsubishi Corp. (34%), Mitsubishi Motor (15%)	Will supply battery packs
	Peugeot Citroen (Fr)			
	Honda	Blue Energy	GS Yuasa (51%), Honda (49%)	Will supply battery packs
<u>JV among Battery makers</u>	Mitsubishi Fuso	Hitachi Vehicle Energy	Hitachi (64.9%), Shin-Kobe Electric (25.1%), Hitachi Maxell (10%)	Divide production responsibilities among group companies: Hitachi Vehicle Energy for automotive, Shin-kobe Electric for industrial, and Hitachi Maxell for consumer
	Isuzu Motor			
	General Motors (US)			
<u>JV among Battery, auto parts/ systems makers</u>	GM (Chevrolet) (US)	Compact Power (US)	LG Chem (Korea) (100%)	Compact Power will produce systems; LG Chem will produce battery cells
	Hyundai?	LG Chem-Hyundai Mobis JV (details TBA)	LG Chem (Korea), Hyundai Mobis (Korea) (details TBA)	JV will produce battery packs (details TBA)
	Daimler (Germany)	Johnson Controls-Saft (US)	Johnson Controls (US) (51%), Saft (France) (49%)	JV will manufacture the battery system
	Ford (US)			
	Chrysler (US)			
	Shanghai Auto (China)			
	BMW (Germany)			
	BMW (Germany)	SB LiMotive	Bosch (Germany) (50%), Samsung SDI (Korea) (50%)	JV will manufacture the battery system
<u>Battery maker solo supply</u>	Volkswagen (Germany)	Sanyo Electric		Announced joint development of HEV Li-ion battery system with VW in May '08
		Toshiba		Announced joint development of EV Li-ion battery / motor with VW in Feb '09
		BYD Company (China)		BYD Auto: Will supply battery packs to own-brand EV/PHEVs Volkswagen: Tie-up for development of HEVs/EVs (announced May '09)
	BYD Auto (China)	LG Chem (Korea)		Will supply battery packs
	Hyundai (Korea)			
	Kia Motor (Korea)	Delphi (systems), A123 (battery cells) (US)		Delphi will supply the battery system, using Li-ion cells from A123
	Shanghai Auto (China)			
	GM (US)	A123 Systems (US)		

Source: Company data, Credit Suisse estimates

Battery materials supply chain

Market trends for primary battery materials

Overview

The four primary materials for lithium-ion batteries (LiB) are anode materials (negative electrode), cathode materials (positive electrode), electrolyte and separators. Since Japanese firms boast a near-monopoly over the global market for all four of these materials, the use of LiB for autos should have a significant impact on earnings of major components makers. As auto use of LiB grows, we are likely to see a change among top-ranked material makers, compared to when LiBs were primarily produced for reduplicative consumer applications. In this respect, interesting major material makers are Kureha, which produces anode materials, and Ube Industries, which produces electrolyte and separators. Moreover, since Mitsubishi Chemical Holdings produces all four materials, it is likely to receive acclaim as a “total solutions provider” as automakers seek to develop their own batteries.

Masami Sawato
(Chemicals)

Picks among battery
material makers: Kureha,
Ube Industries and
Mitsubishi Chemical

Figure 102: LiB-related FY3/10 sales and OP forecasts for chemical makers

	Related products	Lithium-ion battery-related sales (FY3/10 CSE, ¥bn)		% to total company sales & OP	
		Sales	OP	Sales	OP
Asahi Kasei	Separator	26.0	7.0	1.9%	20.0%
Kureha	Binder, Anode material	3.1	0.7	2.1%	8.8%
Mitsubishi Chemical HD	Electrolyte etc.	12.0	3.0	0.5%	6.0%
Ube Industries	Electrolyte, Separator	14.0	5.0	2.5%	19.2%
Hitachi Chemical	Anode material	12.0	4.0	2.8%	16.0%

Source: Company data, Credit Suisse estimates

Figure 103: LiB-related medium-term sales and OP forecasts for chemical makers

		Lithium-ion battery-related sales (¥bn)					Ratio to total company sales		
		2009E	2010E	2011E	2015E	2020E	FY09E	FY10E	FY11E
3407	Asahi Kasei	26.0	29.0	33.0	38.0	48.0	1.9%	2.1%	2.3%
4023	Kureha	3.1	4.0	5.5	8.0	20.0	2.1%	2.5%	3.1%
4188	Mitsubishi Chemical HD	12.0	18.0	25.0	40.0	65.0	0.5%	0.7%	1.0%
4208	Ube Industries	14.0	17.0	23.0	35.0	60.0	2.5%	2.8%	3.5%
4217	Hitachi Chemical	12.0	13.5	15.0	20.0	30.0	2.8%	2.9%	3.1%

		Lithium-ion battery-related OP (¥bn)					Ratio to total company OP		
		2009E	2010E	2011E	2015E	2020E	FY09E	FY10E	FY11E
3407	Asahi Kasei	7.0	7.5	8.5	9.5	12.0	20.0%	16.7%	14.2%
4023	Kureha	0.7	0.9	1.3	1.9	4.8	8.8%	8.2%	8.4%
4188	Mitsubishi Chemical HD	3.0	4.5	6.2	9.5	15.0	6.0%	6.3%	6.4%
4208	Ube Industries	5.0	6.0	8.0	12.0	20.0	19.2%	16.4%	17.6%
4217	Hitachi Chemical	4.0	4.5	4.9	6.5	9.5	16.0%	11.8%	10.9%

Source: Company data, Credit Suisse estimates

Market trends for primary materials

Below, we look at market trends for LiB mainstay materials, anodes, cathodes, electrolyte and separators. We estimate demand for these four primary materials will rise from ¥223bn in 2009 to ¥410bn in 2015, and ¥820bn in 2020, for average annual growth of 13% over 2009-20.

Demand for the four primary
materials likely to increase
to ¥820bn by 2020

Figure 104: Demand outlook for LiB materials

(¥bn)	2009	2015	2020
Lithium-ion battery-related material total	223.0	410.0	820.0
Cathode	120.0	220.0	450.0
Anode	27.0	50.0	100.0
Separator	50.0	90.0	180.0
Electrolyte	26.0	50.0	90.0

Source: Credit Suisse estimates

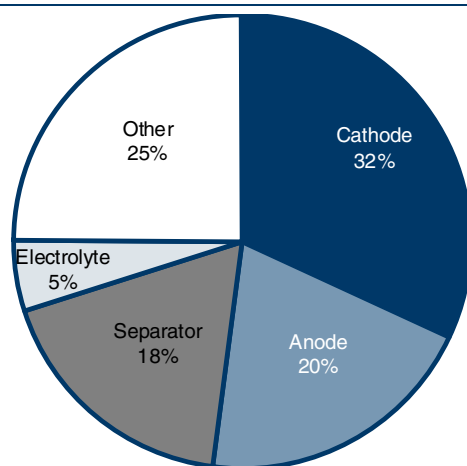
While anticipate strong growth for LiB materials, we also expect firms that played a leading role in supplying materials for consumer-use LiB to be usurped by makers supplying primary materials for automotive LiBs. Figure 30 lists customers of firms producing materials for automotive LiBs. We see companies such as Asahi Kasei (separators) and Hitachi Chemical (anodes) that have commanded top market share for consumer-use LiB materials to be replaced by the likes of Ube Industries and Kureha in tandem with expansion of automotive LiBs.

Likely to see change in leading material suppliers with increasing lithium-ion battery auto use

(1) Cathode materials

Cathodes can be described as the heart of LiB that supply lithium ions. The cathode is the component that controls battery performance, and use of costly cobalt in their production means they have a high material-cost ratio of 32% (our estimate; Figure 31).

Cathodes form the heart of LiB and have a high material-cost ratio of 32%

Figure 105: Cost structure for LiBs

Source: Credit Suisse estimates

Lithium cobalt-oxide is primarily used for consumer-use cathodes, due to its high-power density, high voltage and cyclical features (phenomenon of shrinking battery capacity through repeated charge/discharge). However, the sharp rise in cobalt prices, as well as safety issues has led to the development of alternative materials, such as manganese compounds and ternary (nickel, manganese, cobalt) compounds. Nickel compounds boast a high charge but inferior safety, whereas manganese boast high safety but a lower charge; cobalt falls somewhere between these. A feature of these compounds is their level of safety and high charge compared with cobalt-based lithium cathodes. Batteries used in autos tend to use manganese cathodes due to their high level of safety.

Manganese cathodes main type used in HEV applications

We estimate Nichia commands a 30% share of the market for cathodes used in consumer-use LiB, but expect increased usage of Nippon Denko and Mitsubishi Chemical cathodes in auto applications. Mitsubishi Chemical plans to establish a new mass-production facility for cathode materials, with production capacity of 600t/year, at its Mizushima plant by converting an idle clean-room facility. Production is scheduled to come on stream from

Mitsubishi Chemical likely to expand its share for HEV applications

autumn 2009. The high power output of these cathodes makes them suitable for use in hybrid vehicles. It is also developing cathodes with a low ratio of expensive cobalt. Commercial production is expected to begin once it has secured a customer.

Figure 106: Capacity expansion plan for cathode materials

Composition	Company	Plant	Current capacity	New capacity	Complete
Cathode materials	Mitsubishi Chemical	Kurashiki		600 t/y	Oct-09
	Sumitomo Chemical	Niihama		100 t/m	
	Nippon Mining & Metals	Kitaibaraki		300 t/y	Jun-09
	JGC Catalysts and Chemicals	Niigata	900 t/y	250 t/y	FY3/09
				1,400 t/y	2010
	Tanaka Chemical Corp	Fukui	154 t/m	185 t/m	FY3/10

Source: The Heavy & Chemical Industries News Agency, Credit Suisse

(2) Anode materials

The anode's role is to receive migrating lithium ions from the cathode when charging. Rechargeable LiB generally used a carbon material for the anode, which is usually graphite or hard carbon. While anodes for LiB consumer applications generally used graphite, the use of hard carbon is likely to expand with auto applications.

A feature of Hitachi Chemical's anode materials – which command 40%-plus share of the market for consumer LiB applications – is the spherical mass of synthetic graphite. A feature of synthetic graphite compared with natural graphite is the smooth migration of lithium ions that readily amass in small fissures, facilitating high-speed charge/discharge.

These anodes therefore command a high global share of consumer-use applications, such as mobile-phone batteries. For automotive LiBs, the company is developing a natural graphite anode that is cheaper than synthetic graphite. We believe automakers are in the process of evaluating this anode. Assuming automakers will adopt it, Hitachi Chemical plans to boost overall production capacity by 50% this autumn.

Kureha produces hard carbon anodes that have demonstrated a unique feature of random carbon crystal convergence. Over the medium term, its hard carbon anodes should contribute to earnings through use in LiBs for hybrid vehicles. Automakers and battery makers are testing this product, which is expected to be widely used in HEV LiBs. Hard carbon is particularly suited as an anode material for HEV LiBs due to its heat-expansion resistance when charging, its durability and I/O features. The company already commands a 70% global share of LiB binders, and if we add to this the earnings contribution from HEV LiB anodes, we estimate battery material sales will rise from ¥3.1bn in FY3/10 to ¥8bn in FY3/16 and ¥20bn in FY3/21.

Mitsubishi Chemical, which produces anodes at its Sakaide Plant, plans to boost production by 2,000t this October for annual production capacity of 5,000t.

Figure 107: Capacity expansion plan for anode materials

Composition	Company	Plant	Current capacity	New capacity	Complete
Anode materials	Mitsubishi Chemical	Sakaide	3,000 t/y	2,000 t/y	Oct-09
	Hitachi Chemical	Hitachi	Undisclosed	Undisclosed	Autumn 09

Source: The Heavy & Chemical Industries News Agency, Credit Suisse

(3) Separators

Since direct contact between the cathode and anode would result in the battery shorting, separators are used to physically separate these poles. Separators are one of two types, wet or dry, and we forecast dry separators will become mainstream for automotive LiBs, despite wet-type being mainstream for consumer use.

Likely to see increased use of hard carbon anodes in automotive LiBs

Hitachi Chemical boasts top share for consumer use applications

Kureha's hard carbon anodes for automotive LiBs receiving high acclaim

Mitsubishi Chemical boosting capacity

A feature of wet-type is that their strength enables the production of a thin film. They also enable easy design for the microporous holes that allow lithium ions to pass through. Since separators have to be porous to allow lithium ions to pass through, easy design of the microporous holes is important. However, creating these holes requires a large amount of solvent, and handling these solvents is difficult as organic solvents are mostly used, which contribute to cost growth.

Bottleneck for wet-type is
their high cost

On the other hand, dry separators are low-cost, while they are not affected by the problem of shorting, as uniaxial stretching prevents contraction of width direction. In contrast, wet-type use dual-axial stretching, which exposes them to the problem of shorting as the heat generated could result in contraction leading to contact between the poles. Moreover, as the dry-type do not use organic solvents they are more environmentally friendly. Given the recent increase in high capacity LiBs, we anticipate growth for dry separators as they are more suitable to large capacity LiBs.

Dry-type are low cost and
solve the issue of shorting

Asahi Kasei commands a 50%-plus share of the market for consumer-use LiB separators. Based on the increasing demand for LiBs, it plans to boost separator production capacity from a current 100mn sqm to 200mn sqm by FY3/11. In addition to wet separators, it is developing dry-type for auto applications and is at the prototype stage. However, its market share is likely to decline in the field for auto applications.

Asahi Kasei commands a
50%-plus share of
capacitors for consumer
application, but a concern is
shrinking market share for
auto-use

We expect Ube Industries to expand sales of separators for automotive LiBs through adopting the dry method, which is lower cost than the wet method. The company has steadily expanded production over six years, and we understand its newest facilities are already operating at full utilization, for management to consider further expansion. Its separators use polyolefin as their raw material and use neither solvents nor inorganic fillers in the production process. They also boast excellent solvent and chemical resistance.

Look for Ube Industries to
expand sales of dry-type
separators for auto use

For Mitsubishi Chemical, which produces all four primary materials, it is already testing separator prototypes using commercial production testing facilities at the Nagahama Plant of its subsidiary Mitsubishi Plastics. The company began production this summer aiming for commercial production of 12mn sqm/year using the Nagahama facilities as its base.

Mitsubishi Chemical also
geared up for commercial
production

Figure 108: Capacity expansion plan for separators

Composition	Company	Plant	Current capacity	New capacity	Complete
Separator	Asahi Kasei Chemicals	Moriyama	100 mn sqm/y	50 mn sqm/y	Summer 09
				15 mn sqm/y	Spring 10
		Hyuga		20 mn sqm/y	Feb-10
				20 mn sqm/y	Spring 10
	Sumitomo Chemical	Niihama	16 mn sqm/y	9 mn sqm/y	Sep-09
				25 mn sqm/y	FY3/12
	Ube Industries	Ube	Undisclosed	Undisclosed	FY3/9
	Tonen General Sekiyu	Korea		30 mn sqm/y	2009
	Mitsubishi Plastics	Nagahama		12 mn sqm/y	Summer 09

Source: The Heavy & Chemical Industries News Agency, Credit Suisse

(4) Electrolytes

Electrolytes act as a carrier for lithium ions between the cathode and anode, and are formed from organic solvents, electrolyte (lithium hexafluorophosphate [LiPF₆]) and additives. Electrolytes play the role of fine tuning the functions of the battery as a whole, and the value-added function of preventing the battery from burning through replacing the additive.

Electrolyte high value added

Ube Industries, which already commands a 30%-plus share of the market for electrolytes, is actively looking to supply auto-use, as well as consumer-use electrolytes to major battery makers. We thus look for sales expansion of these products along with separators. Its electrolytes are highly acclaimed for their superior additives that produce safe electrolytes that do not burn easily.

Ube Industries aiming to
expand share for auto
applications

Mitsubishi Chemical produces electrolyte at its Yokkaichi Plant, and plans to boost production capacity from a current 6,000t/year to 8,500t/year by January 2010.

Mitsubishi Chemical also planning to boost capacity

Figure 109: Capacity expansion plan for electrolytes

Composition	Company	Plant	Current capacity	New capacity	Complete
Electrolyte	Mitsubishi Chemical	Yokkaichi	6,000 t/y	2,500 t/y	Jan-10
	Central Glass	Kawasaki		a few hundred t/y	FY3/10
DMC	Ube Industries	Ube	3,500 t/y	2,500 t/y	Spring 09
LiPF ₆	Kanto Denka Kogyo	Kurashiki	950 t/y	350 t/y	FY3/10
	Morita Chemical Industries	Sakai		500 t/y	End 09
		China	480 t/y	480 t/y	

Source: The Heavy & Chemical Industries News Agency, Credit Suisse

Copper foil market

Furukawa Electric to maintain leadership position in automotive LIB copper foil market

Shinya Yamada
(Basic materials sector)

Conclusion

Currently, we believe the best-placed company in the copper foil market for automotive LiBs is Furukawa Electric, the world's largest producer of copper foil for LiBs. We expect the size of the copper foil market for LiBs to be around ¥36bn in FY2015, with Furukawa Electric holding a market share of around 50%. Over the next two to three years, we do not expect any major impact on earnings, but over the long term see a possibility this business could become a key driver of earnings.

Main uses of copper foil

Copper foil is used for making cathodes (conductors) for LiBs. Cathodes are made by coating carbon, the negative active material, with copper foil on both sides, and then drying and pressing. Copper foil for negative current collectors is either electrolytic copper foil or rolled copper foil. Aluminum foil is used to make the anode.

Advantages of electrolytic copper foil

LiBs for mobile products such as cellphones mostly use electrolytic copper foil, and we believe electrolytic copper foil is also more useful even in automotive applications. In particular, Furukawa's WS foil has the advantage of being much more resistant than rolled foil to the expansion and contraction caused by the heat hysteresis cycle associated with repeated charging and discharge (due to its tensile strength and coefficient of expansion). Also, we expect electrolytic foil is cheaper to produce than rolled foil when thin foil is required for batteries and other applications. As we estimate copper foil accounts for around 10% of the cost of LiBs, this cost difference is important. We estimate the high current requirements mean the thickness of copper foil used for automotive applications is around 50% thicker than the foil used for mobile applications. However, it is still only half as thick as the commodity copper foil used in making printed circuit boards, which represents a large market, and can still be classified as thin foil.

Types of copper foil

Electrolytic copper foil is a thin sheet made by electrolyzing copper using a titanium cathode, and then removing the layer of copper which adheres to the cathode. However, rolled copper foil is made by passing copper between two rollers, to create a thin sheet. The difference in these two production processes means that electrolytic copper foil is more expensive the thicker it is, while rolled copper foil is more expensive the thinner it is. While the width of rolled copper foil is around 60cm, electrolytic copper foil can be made in widths of up to 1.3m.

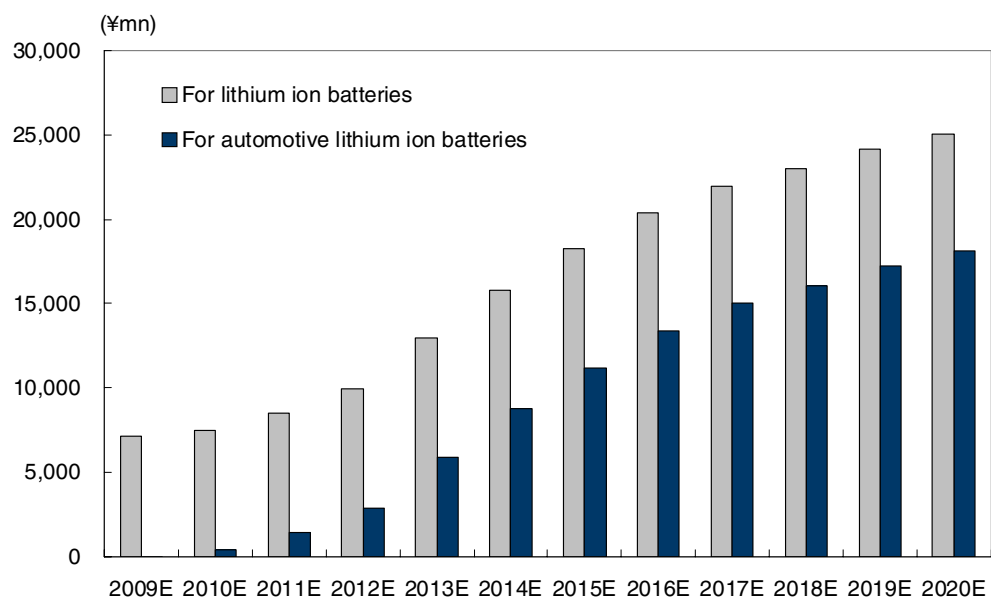
Furukawa Electric is the market leader in copper foil for LiBs

Furukawa Electric has a global market share of more than 50% for the copper foil used in LiBs, while in Japan it has a market share of more than 70%. The world's second-largest producer is Iljin Copper Foil in Korea, while the third-largest is Nippon Denkai. We expect Furukawa Electric's share for automotive applications to rise to more than 50%. In real terms, orders for automotive applications appear to be picking up.

Market scale

The market for copper foil for LiBs for the auto industry is in its infancy, and the market hardly exists yet. Furukawa Electric plans to increase its production capacity for copper foil for lithium ion batteries from 5mn m² per month currently to 7.5mn m² per month by 2012. It expects 700,000 m² per month to go to the auto industry. Based on our forecasts for the LiB market, we expect total sales to be 3,570,000 units in 2015, and the scale of the copper foil market for LiBs to be around ¥36bn.

Figure 110: Furukawa Electric's sales of copper foil for LiBs



Source: Credit Suisse estimates

Electronic components: Nidec and Rohm to benefit

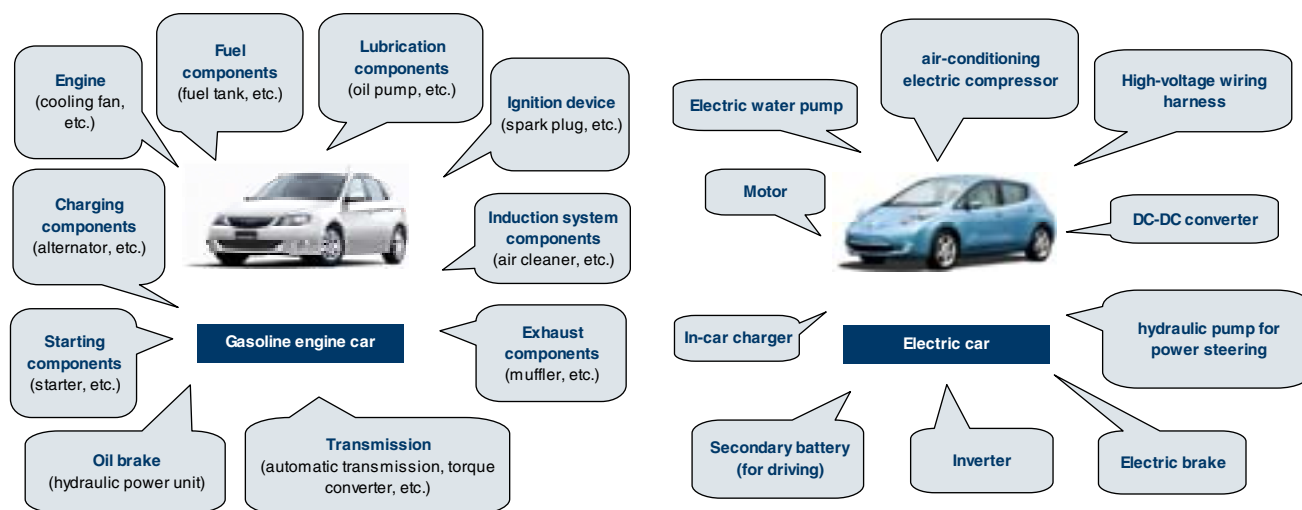
Overview: Conventional combustion-engine vehicles contain as many as 50,000-100,000 parts, whereas for electric vehicles (EV) this number is reduced to 20,000-30,000 parts. Given the wide range of parts that EV therefore no longer require, including combustion engines (the engine accounts for 10,000-30,000 mechanical components, including pistons, valves, crankshaft, etc), transmissions (mechanical components including bearings, valves, clutch, etc), induction system parts (including throttle valves), exhaust parts (muffler, etc), fuel system parts (fuel tank and pump, etc), lubrication system parts (oil pump, etc), ignition coils and starters, EV proliferation is likely to have a major impact on conventional autoparts makers.

Masashi Itaya
(Electronic components)

On the other hand, EVs offer electronic component and devices makers substantial business opportunities. The change in power train ensuing from the emergence of EV creates new markets for rechargeable batteries and vehicle drive motors (100kW level), as well as for power converter equipment essential to drive motors such as inverters and converters. Also, eliminating the vehicle engine means that engine-driven compressors and oil pumps become electrically-driven. With the shift from hydraulic drive to electric drive, we forecast the market for mid-sized brushless motors generating several hundred watts will significantly expand.

Among these components, rechargeable battery makers should enjoy significant merit, while we are particularly interested in the competitive advantage electronic component and devices makers have in the field of power devices and mid-sized brushless motors, in which area there is limited risk of automakers producing them in-house. Companies that look to particularly benefit are Nidec, which is focussing its efforts on vehicle motors, and Rohm, which leads in the development of SiC power devices. Among component firms, TDK and Nichicon should benefit from expansion of the green-car market.

Figure 111: Components that will disappear with the change in power train and those that will become essential



Source: Company data, Credit Suisse

Drive motors

The general view is that automakers will produce EV drive motors in-house, as: (1) these form the core component of EV and represent a field that automakers as traditionally excel in as machinery manufacturers, and (2) 100kW-class compact motors capable of variable speed control have been nonexistent until now. Nevertheless, drive motor production is not being carried out entirely in-house, as Meidensha supplies the drive motor for Mitsubishi Motors' *i MiEV* vehicle, while Yaskawa Electric developed the motor for Mazda Motors' *Premacy Hydrogen RE Hybrid* vehicle which is powered by a hydrogen rotary engine and sold on lease. Besides these lower-tier Japanese automakers, Magna is expected to supply the drive motor for Ford Motor's EV *FordBev*, while Volkswagen is jointly developing an EV drive motor with Toshiba.

The output of drive motors is around 100kW, significantly more than the several watts to several hundred watts for motors used in conventional vehicles. We estimate the commercial production cost of drive motors is ¥50,000-100,000 based on the cost of existing engines, while their price is to some extent proportional to their power output (for small production levels the cost is several hundred thousand yen). We estimate an EV market to the scale of ¥50-100bn assuming 1mn units, making this an attractive market for motor makers once a market for external sales is established. Besides companies such as Hitachi, Toshiba and Mitsubishi Electric, we see opportunities for mid-size electronic equipment makers such as Meidensha, Yaskawa Electric and Sinfonia Technology. Among components makers, Nidec is actively developing products in conjunction with a number of firms.

Of particular interest among drive-motor parts are neodymium sintered magnets. We estimate motors with an output of 50-100kW will require a 1kg magnet. And assuming a price of ¥5-10 per gram and EV market of 1mn units, this translates into a market to the scale of ¥5-10bn, which is shared by Hitachi Metals, Shin-Etsu Chemical and TDK. Neodymium magnet profitability is greatly swayed by raw material prices, but if we ignore this factor, this business should provide stable profit levels. For motor cores, on the other hand, it is difficult to expand earnings. Mitsui High Tec supplies motor cores for the Toyota *Prius*, and Kuroda Precision for the Honda *Insight*. Moreover, this looks to be nothing more than a processing cost business, as automakers are fully aware of the cost structure.

Figure 112: Green-car components supply chain and spec comparison

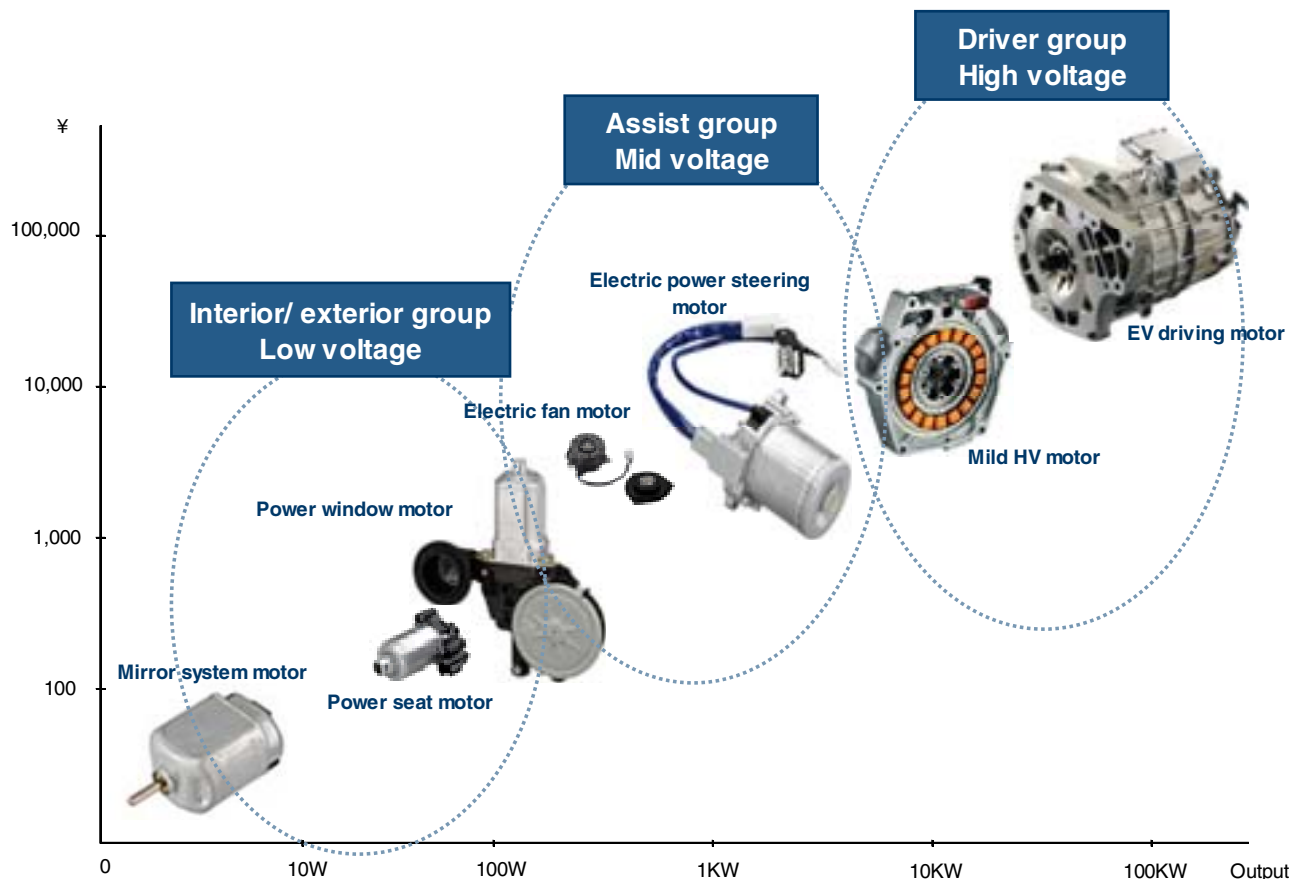
Car maker	Toyota	Honda	Mitsubishi	Fuji Heavy Industries	Nissan	Ford	VW
Model	Prius	Insight	i-MiEV	Plugin STELLA	Leaf	Ford BEV	EV development partnership
Main Motor (Motor output)	Toyota 60KW	Honda 10KW	Meidensha 47KW	Fuji Heavy Industries 47KW	Nissan 80KW	Magna -	Toshiba -
Motor core	Mitsui High Tec	Kuroda Precision	Meidensha	N.A.	N.A.	N.A.	N.A.
Sintered neodymium magnet	TDK/ Shin-Etsu Chem	TDK	N.A.	N.A.	N.A.	N.A.	N.A.
Secondary battery	Panasonic EV Energy	Sanyo Ele	GS Yuasa	Automotive Energy Supply	Automotive Energy Supply	Johnson Controls-Saft	Toshiba
(Battery capacity)	1.3kw h	580w h	16kw h	9kw h	24kw h	N.A.	N.A.
(Voltage)	201.6v	100.8v	330v	346v	345v	N.A.	N.A.
Inverter	Toyota Industries	Mitsubishi Ele	Meidensha	Nichicon	Nissan	Magna	Toshiba
DC-DC converter	Toyota Industries/ TDK	TDK	Nichicon	Nichicon	TDK	Magna	N.A.
Charger	—	—	Nichicon	Taihei Denki	Nichicon	Magna	N.A.

Source: Company data, Credit Suisse

Mid-size brushless motors

Roughly 60-120 motors are installed in a vehicle. The market is largely formed from previously manually operated vehicle functions becoming electrically operated to enhance ride comfort. Currently, we are seeing a proliferation of motor use in optical axis adjustment, electric seats and parking brakes. For these interior/exterior motors with low power output of several watts to 100W, low-cost brushed motors priced from several tens of yen to several hundred yen tend to be used. Over recent years, however, the increase in automotive-use motors is being spurred by a changing powertrain due to tougher CO₂ emission restrictions and the emergence of EV. For example, engine oil pumps and water pumps are becoming electronically operated, to reduce energy consumption, while power steering and dual-clutch transmissions originally hydraulically driven are becoming electrically powered. Moreover, once engines disappear from vehicles, electrically powered air conditioner (A/C) compressors will be needed. To perform these functions, motors need an output of several hundred watts (mid-voltage), and we believe highly efficient brushless motors, with their greater longevity, are likely to become mainstream. The cost of these motors is high, at several thousand yen, and offers huge business opportunities for related firms.

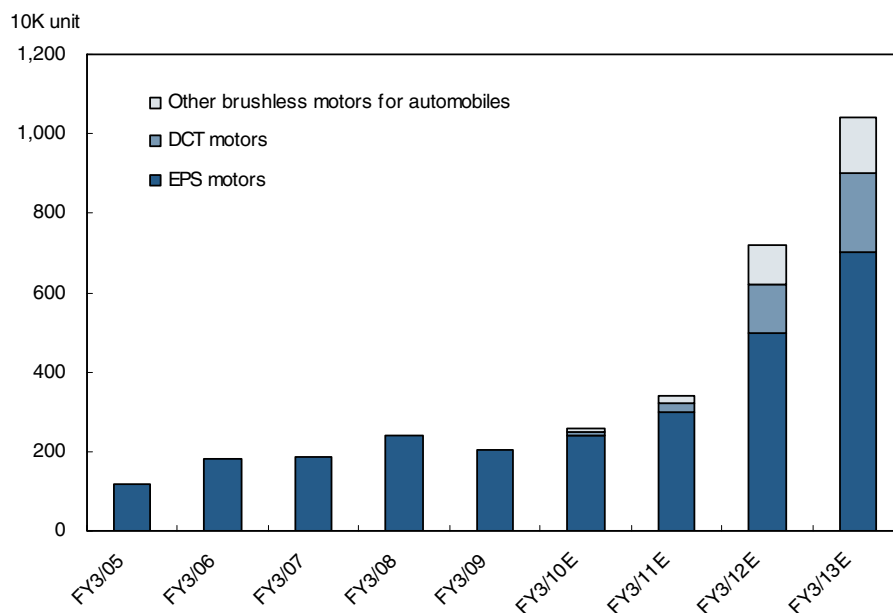
Figure 113: Motor output and prices



Source: Company data, Credit Suisse

Nidec is pouring most efforts into midsize motor development as it sees the market as the mid-term growth driver. The company has already gained a leading position in the market for electric power-steering motors, reflecting its technological strength in the field of brushless motors as well as its cost competitiveness as an electronics maker with the ability to offer customized motors competitive in terms of both price and quality. Besides its lead in the field of power-steering motors, Nidec is also focusing efforts on gaining orders in the five fields of dual-clutch transmission motors, HEV battery cooling fans, engine cooling fans, oil-pump motors and EV/HEV main motors. Based on current development projects, we estimate Nidec's shipments of midsize brushless motors for automotive applications will total roughly 10mn units by FY3/13, to generate sales close to ¥50bn. Moreover, given these fields it is focusing on, we expect sharp earnings expansion to continue after FY3/13.

Figure 114: Trends in Nidec's shipments of brushless motors for automotive use



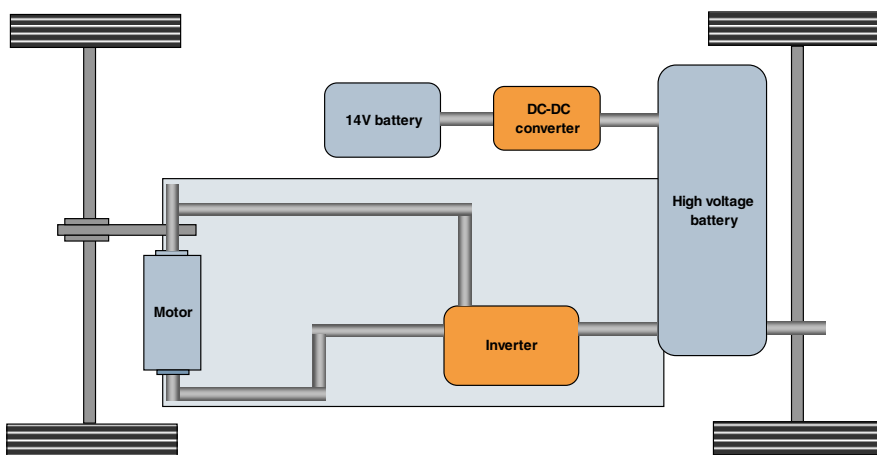
Source: Company data, Credit Suisse estimates

Power converters (inverters, DC-DC converters)

EV are equipped with high-voltage rechargeable batteries of more than 300V. Car accessories such as A/Cs, wipers and lights are 14V driven as before and so are powered by 14V lead-storage batteries. The role of DC-DC converters is to recharge 14V lead-storage batteries from a 300V rechargeable battery. The role of inverters, however, is to convert the rechargeable battery's DC voltage into an alternating current (A/C) voltage for the motor drive and convert the A/C voltage generated by the motor into DC voltage. Many automakers, have integrated into power control units (PCU) power converters such as DC-DC converters and inverters as well as engine control units (ECU).

However, inverter and DC-DC converter supply chains differ. Inverters control the drive motor, and as a vehicle's ride can be affected unless inverters are optimized through use of control software, drive motor makers tend to handle inverter production. DC-DC converters, on the other hand, offer electronic component makers with power-source knowhow business opportunities. Already TDK, Nichicon and Shindengen have track records in this field, and TDK in particular already supplies six firms, commanding a around 20% share of the DC-DC converter market. To pursue product value-added for DC-DC converters, similar to conventional power sources the key is to supply components installed in power converters. TDK, for example, is able to supply transformers and MLCC, as well as aluminum and film capacitors through its acquisition of EPCOS. Nichicon and Shindengen, on the other hand, can supply internally components such as film capacitors and power devices, respectively.

Figure 115: EV powertrain image



Source: Company data, Credit Suisse

Power devices

Power converter prices vary considerably based on the motor's output and battery capacity. For EV requiring motor output of 100kW, we estimate even in the commercial production stage the cost including inverter and DC-DC converter will be around ¥100,000. Power semiconductors account for a large portion of this cost. In particular, we estimate a sharp rise in demand for insulated-gate bipolar transistors (IGBT) that can handle large electric currents of 100A under high voltages of more than 600V, and form the core component of inverters controlling the drive motor.

In fact, the second-generation *Prius* (motor output 50kW), is equipped with 18 IGBT as power semiconductors controlling the drive motor. If we add to this power MOSFET used for DC-DC converter switching devices and diodes to prevent reverse electric currents, the amount of power semiconductors used is roughly equivalent to one-quarter of a 6-in wafer. Moreover, in the case of the *Harrier* hybrid (Lexus *RX* overseas), where power output is 123kW, the number of power semiconductors used is double that of the *Prius*. The cost of these power semiconductors is uncertain, but research suggests that motor control semiconductors (primarily IGBT) priced at \$800 were used in luxury hybrid models launched in 2006.

Figure 117 shows market share for power discrete devices. IGBTs are classified into power transistors, and their 2008 market scale was \$2.3bn – equivalent to one-quarter of the power transistor market. Moreover, there have been a limited number of entrants to this market, with Mitsubishi Electric, Fuji Electric, Infineon and Toshiba commanding high market shares. Since these are highly customized products, material and processing know-how pose high barriers to market entry. On the other hand, as for power diodes fast recovery diodes are used for high-voltages, and companies commanding stable shares of this market are Vishay, ON Semiconductor, Shindengen and Nihon Inter Electronics. As Figure 42 shows, Toyota Motor and Denso are actively producing power semiconductors in-house.

Figure 116: Sales and market share of power transistors and power diodes (2008)

Unit: \$mn

	Power transistor			Power diode		
	Company	Sales	Share	Company	Sales	Share
1	Infineon Technologies	932	12%	STMicroelectronics	508	16%
2	Fairchild Semiconductor	892	11%	Vishay	337	11%
3	Toshiba	789	10%	Microsemi	236	7%
4	Mitsubishi	636	8%	Shindengen Electric	231	7%
5	International Rectifier	602	7%	Toshiba	187	6%
6	Vishay	550	7%	Nihon Inter Electronics	179	6%
7	STMicroelectronics	548	7%	ON Semiconductor	166	5%
8	Fuji Electric	490	6%	Lite-On Semiconductor	132	4%
9	ON Semiconductor	322	4%	Pan Jit	131	4%
10	NEC Electronics	285	4%	NXP	111	4%
11	Rohm	245	3%	Hitachi	110	3%
12	Renesas Technology	202	3%	Sanken	109	3%
13	NXP	171	2%	Renesas Technology	98	3%
14	Panasonic	169	2%	Robert Bosch	90	3%
15	IXYS	150	2%	International Rectifier	90	3%
16	Sanyo Semiconductor	138	2%	Fuji Electric	87	3%
17	Jilin Sino-Microelectronics	111	1%	Diodes	87	3%
18	Shindengen Electric	102	1%	Rohm	79	2%
19	Toyota	102	1%	Alpha & Omega Semiconductor	58	2%
20	Sanken	90	1%	Fairchild Semiconductor	40	1%
21	Denso	85	1%	California Micro Devices	40	1%
22	Diodes	84	1%	Semtech	31	1%
23	Hitachi	82	1%	Sanyo Semiconductor	12	0%
24	Microsemi	61	1%	Toyota	5	0%
25	Alpha & Omega Semiconductor	48	1%	Toyota Industries	5	0%
-	Others	174	2%	Others	2	0%
	Total Market	8060	100%	Total Market	3161	100%

Source: Gartner, Credit Suisse

SiC power devices

Silicon (Si) semiconductors such as IGBT noted above are approaching the limit to their theoretical performance determined by their physical properties, which suggests further significant gains in performance are difficult. Given this, automakers are keenly interested in wide-gap semiconductor power devices that use silicon carbide (SiC).

Figure 43 compares the physical properties of Si and SiC, and clearly illustrates how SiC boasts a number of advantages. Particularly attractive for automakers is SiC's strong heat resistance. Since Si IGBT do not perform normally when exposed to temperatures of 150°C or more, they require air or water cooling. Such cooling ultimately leads to enlargement of the chip's thermal casing design, which can impair a car's performance. Thus, there is a need to find cooling solution that enables the smallest possible thermal casing design. However, by switching from Si-IGBT to SiC-MOSFET, a vehicle's cruising range improves by 10% simply through inverter efficiency. Moreover, this enables a reduction in wind resistance through decreasing the size of the inverter and radiator, and coupled with the reduction in vehicle weight improves actual cruising range by close to 30%.

Significant improvements have been made to wafer micro-pipe defects in SiC power devices that plagued these devices several years ago. Already overseas makers such as Infineon, Cree and STMicroelectronics have commercialized SiC-Schottky barrier diodes (SBD) to create a market. The remaining issue is wafer cost, but Cree, which controls an estimated 70% of the market, plans to use 6-in wafer input in 2009. Moreover, with the Chinese firm TakeBlue Semiconductor's active market entry, as well as other new entrants such as Showa Denko and Nippon Steel Materials, wafer prices should start to come down.

Japanese firms have yet to commercialize SiC power devices. The only announcement so far on this front is Nihon Inter Electronics' obtaining front-end processed SiC wafers from Cree and undertaking back-end production after that. Notable, however, are Rohm's development efforts. In 2007, the company successfully developed the world's first trench-type SiC-MOSFET and in 2008 announced development of EV SiC power devices along with Nissan Motor and Honda Motor. This July, Rohm acquired a SiC wafer maker and we estimate it will roll out SiC-SBD and SiC-MOSFET businesses within the next 1-2 years. We view Rohm as the best positioned to benefit from expansion of the SiC power devices market, given its scale, and development of packages and devices.

Figure 117: Property comparison of Si with SiC

- SiC comes in three types: 4H and 6H hexagonal crystals and 3C cubic crystals. 4H is the main choice for power devices given its high electron mobility. The trench format lowers resistance and supports larger electric current.
- **Wide band gap:** Allows for device operation at high temperatures; while Si devices have a maximum temperature range of 150-200°C, SiC devices can theoretically operate at temperatures of 800°C and higher, reducing the need for cooling fans and other heat-dissipation parts and supporting more compact cooling elements.
- **Electron saturation speed twice as fast as Si:** supports high-frequency operation and smaller switching power-source inductors and other peripheral parts.
- **High breakdown field strength:** allows for a thinner voltage-handling section that reduces on resistance when electric current starts flowing and switching losses; higher voltage resilience raises resistance value and significantly undermines efficiency when utilizing Si devices in power systems.
- Switch from Si to SiC power devices cuts losses to 1/5 and volume to 1/25 for inverter applications; 1/4 of a 6-in wafer is required for hybrid-car usage with an Si device, but switching to an SiC devices reduces necessary volume by another 1/4.

Property comparison between SiC and Si

Material		4H-SiC	6H-SiC	3C-SiC	Si
Band gap	eV	3.26	2.93	2.23	1.12
Electron mobility	μ_e (cm ² /Vs)	1000/850	80/400	800	1400
Hole mobility	μ_h (cm ² /Vs)	115	90	40	600
Breakdown field strength	E_c (V/cm)	2.5×10^6	2.8×10^6	1.2×10^6	3.0×10^5
Thermal conduction	λ (W/cmK)	4.9	4.9	4.9	1.5
Electron saturation speed	V_{sat} (cm/s)	2.2×10^7	1.9×10^7	2.0×10^7	1.0×10^7
Electric permittivity	ϵ	9.7	9.7	9.7	11.8
Bulk growth	-	$\Delta \rightarrow \bigcirc$	$\Delta \rightarrow \bigcirc$	$\times \rightarrow \Delta$	$\odot$
Epitaxial growth	-	$\Delta \rightarrow \bigcirc$	$\Delta \rightarrow \bigcirc$	$\times \rightarrow \Delta$	$\odot$
Device type		Vertical power element	GaN LED substrate	Intermediate capacity power element	General

Note: $\odot$ =Excellent, $\bigcirc$ =Good, Δ =Normal, $\times$ =Bad

Source: Company data, Credit Suisse

Figure 118: Efforts to boost use of SiC power devices and Rohm's initiatives

2002	-	Infineon develops the world's first SiC Schottky diode and releases a 3rd-generation version in 2009; unit prices for orders of 10,000 units are €0.61 for 600V, 3A products, €0.85 for 600V, 4A products, and €1.89 for 600V, 8A products
2005	-	Release of 4-in SiC substrates
	-	Rohm develops an SiC power MOSFET that reduces losses to 1/40 of Si products with on resistance at 7.15m Ωcm² and voltage at 1,000V
2006	-	Mitsubishi Electric develops an SiC device with 1,200V voltage and 10A current and achieves an industry-first success of driving a three-phase motor with an inverter based on this device
2007	-	Significant reduction of micropipe defects negatively affecting device operation; Cree announces 4-in substrates with almost no micropipe defects in May and Nippon Steel makes a similar announcement in June; Cree releases its product in July
	-	Kyoto University, Tokyo Electron and Rohm jointly develop the first multi-wafer batch processing technology for an SiC epitaxial film growth system in Japan
Dec		Rohm develops the industry's first trench-type SiC-MOSFET and successfully prototypes large-capacity devices with 100A+ current capacity on 3mm x 3mm (vs the previous limit of 10A to a few 10A on a similar-sized device); it also develops an SiC-SBD with 300A current capacity on a 10mm x 10mm chip that sharply reduces electricity losses with on resistance at 1/85 of Si-DMOS and 1/5 of Si-IGBT (current mainstream devices)
2008	May	ST Microelectronics releases an SiC diode in May (third after Infineon and Cree)
	Jun	Rohm announces the development of an SiC diode with a new structure for EVs that increases breakdown resistance tenfold with Nissan Motors in June; it has started working on volume-production technology and hopes to achieve early commercialization
	Sep	Rohm announces the development of high-power inverter module (1,200V, 230A) using SiC-SBD and SiC-MOSFET devices for next-generation EVs with Honda in September; this is the industry's first full-SiC inverter module
	Dec	Showa Denko's full-scale entry into SiC wafer business
2009	Feb	Mitsubishi Electric confirms a 70% reduction of electricity losses in an 11kW SiC-based inverter compared to a similar product using an Si power device
	Apr	Nippon Steel Materials, a Nippon Steel subsidiary, starts production and sales of SiC monocrystal wafers
	Apr	Nihon Inter announces to produce SiC-SBD procuring front-end processed wafers from Cree
	Jul	Rohm acquires Germany SiC wafer maker
	Sep	Hitachi Kokusai develops anneal equipment for SiC semiconductor and plans to start shipment from 2010
	Sep	TankeBlue Semiconductor, Chinese SiC wafer maker, announces to increase production of 3-in wafer (this company is known for reducing 2-in wafer price dramatically)

Note: Red news are related to Rohm and blue to wafers.

Source: Company data, Credit Suisse

Risk factors for auto LiB market

Summarized points:

- Impact of LiB materials supply constraints and price increases on production
- Risks of supply constraints for non-battery products such as motors (rare earth and heavy rare earth additives)
- Assumptions of a reduction in prices per Wh (cost)
- Changes in the capacity of batteries mounted on HEVs, PHEVs and EVs
- Forex volatility risk

Impact of LiB materials supply constraints and price increases on production

Among the main materials for LiBs, lithium, nickel and cobalt are often mentioned as facing risks of supply constraints or price increases. However, for lithium, according to our US Specialty Chemicals team's analysis there is very low risk of supply shortages. In addition, while there are no concerns about supply volume, there is a risk of a price increase for copper, large quantities of which are used in wiring. Accordingly, alternatives such as aluminium are being researched.

Supply constraint risks outside the battery area; rare earth magnets for motors

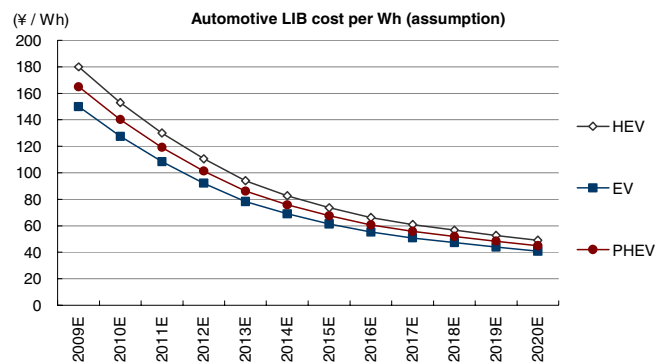
Potential supply constraints for electrical vehicle components relate not only to batteries, but also to drive motors. Currently, for HEV and electric vehicle drive motors, Nd sintered magnets (main materials are neodymium [Nd], iron [Fe] and boron[B]), which have the strongest magnetic attraction of any man-made permanent magnet in the world, are used. Other additives include dysprosium (Dy) and terbium (Tb), which are rare earths used to avoid reduction of magnetic properties at high temperatures. Currently, each drive motor uses around one kilogram of this permanent magnet material, with Dy accounting for around 7-10% of this total.

Currently, over 90% of global production of neodymium and dysprosium is carried out in China, and the Chinese government is tightening the regulations on the mining, development and export of these materials every year (Figure 48). Accordingly, if the demand for rare earth materials sharply rises due to use in drive motors, this could lead to a shortage of supply.

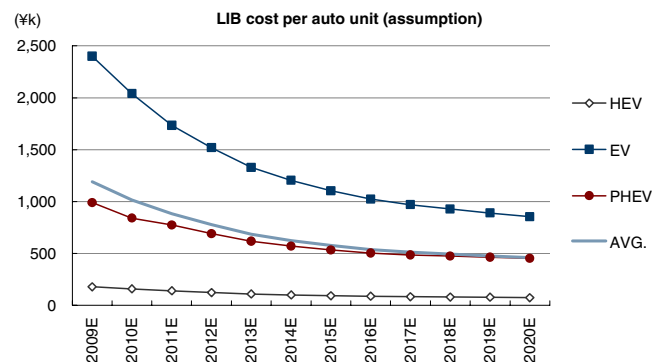
Currently, makers are concentrating on developing magnets which use much less Dy, since it is so rare, and in the next few years we expect mass production of this new generation of magnets. Also, while there is the disadvantage that weight and volume may increase sharply, some motors are being produced without the use of rare earth materials. Accordingly, concerns over a shortage of supply may prove groundless. However, while this may not do much to slow down the increased diffusion of electric vehicles, currently we should note that there is still a risk. For details, please see Page 42 (Appendix 1).

Assumptions of a reduction in prices per Wh (cost)

Our automotive LiB assumes the total cost per Wh of batteries for EVs will be around ¥150/Wh in 2009, falling to ¥61/Wh in 2015. However, cost reductions stemming from mass production and technological reform, and cost reductions stemming from lower raw material prices could be faster or slower than expected.

Figure 119: LIB cost per Wh for HEV, EV, PHEVs

Source: Company data, Credit Suisse estimates

Figure 120: LIB cost per auto unit for HEV, EV, PHEVs

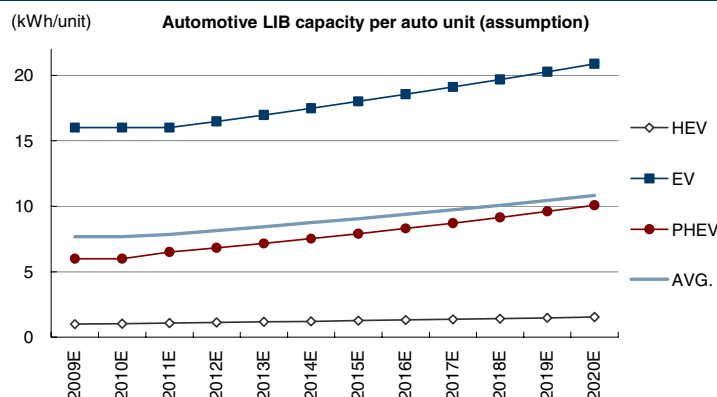
Source: Company data, Credit Suisse estimates

Assumptions on capacities for batteries fitted to HEVs, PHEVs and EVs and impact on costs

Our initial assumptions for 2009 looked for the average capacities of LiBs fitted to different types of vehicle to be around 1kWh per unit for HEVs, 6kWh for PHEVs and 16kWh for EVs. However, along with a reduction in cost per unit, we also expect a gradual increase in battery capacity, and by 2020 expect average capacities to be 1.5kWh per unit for HEVs, 10kWh for PHEVs and 21kWh for EVs. However, there are no clear standards, and we expect various capacities depending on individual vehicle makers and models. Accordingly, future estimates of the battery market size would also be expected to fluctuate.

For example, the *i-MiEV* launched by Mitsubishi Motors uses a 16kWh battery, while Fuji Heavy Industry's plug-in *Stella* uses a 10kWh battery. Some say the standard PHEV battery capacity would be around 6-10kWh per unit; however, General Motors' *VOLT*, also categorized as a PHEV, is expected to use around 16kWh. Nissan Motors' *Leaf*, which will be launched in 2010, will use around 24kWh per unit, or around 1.5x the capacity of the *i-MiEV*, although both vehicles are categorized as an EV.

Since the *i-MiEV* is expected to be able to run for around 160km on one charge using 16kWh in battery capacity, when considering the balance between maximum range and battery capacity, one can assume around 1kWh per 10km. However, Nissan's *Leaf* is expected to have a range of more than 160km for 24kWh of battery capacity, indicating a figure of only 6.7km per charge. Nevertheless, since we do not expect the cost of the 24kWh fitted to the *Leaf* to be 1.5x the cost of the 16kWh fitted to the *i-MiEV*, it is important to note that when calculating the total size of the market, we have adopted a standardized cost.

Figure 121: Automotive LiB capacity assumption per auto unit

Source: Company data, Credit Suisse estimates

Appendix: Worldwide Lithium

The following is an excerpt from the report published by the US Specialty Chemicals team on October 1, 2009. The report is titled “Extracting the Details on the Lithium Market.”

US Specialty Chemical Team

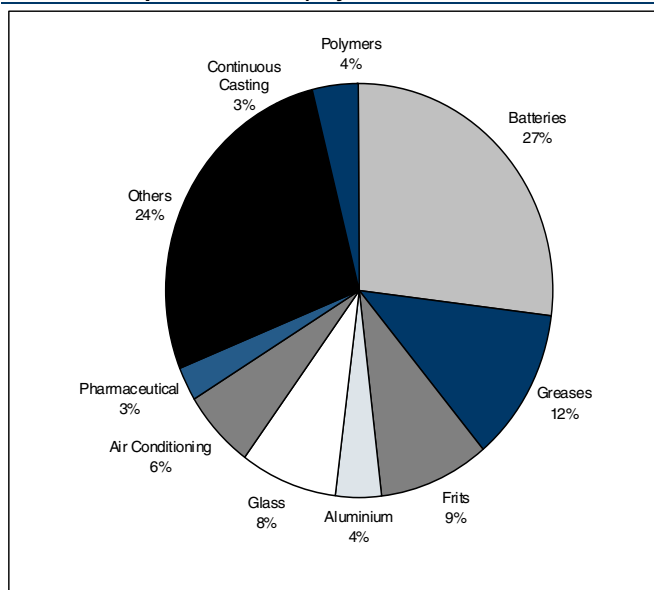
John McNulty, CFA
212 325 4385
john.mculty@credit-suisse.com

Alina Khaykin
212 538 2664
alina.khaykin@credit-suisse.com

Lithium Uses/End-Markets

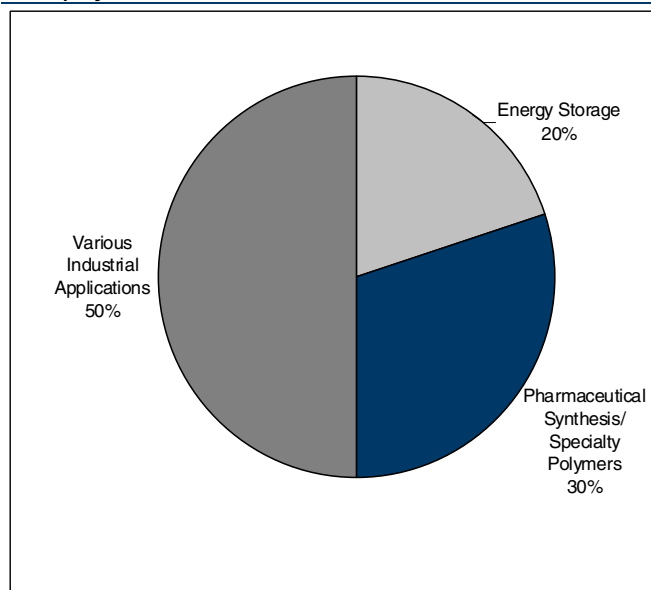
Different lithium compounds are used in a variety of end markets, including energy storage, pharmaceutical synthesis, specialty polymers, and a host of industrial applications such as glass and ceramic production, high performance greases, and gas and air treatment, etc (Exhibit 3). What is also important to note is that the value/price of lithium varies greatly relative to the volumes depending on the grade and/or value-added component—for example, while polymer and pharmaceutical grade lithium accounted for 7% of the volumes in 2008, they accounted for roughly 30% of the value of all products sold, though batteries accounted for 27% of the demand but less than 20% of the total value of lithium sold.

Exhibit 122: Global Lithium Consumption (in lithium carbonate equivalent units) by End Market, 2008



Source: SQM, Credit Suisse estimates

Exhibit 123: Value-Added Lithium Consumption (in dollar value) by End Market, 2008



Source: FMC, Credit Suisse estimates

Energy Storage (20-25% of global lithium market)

Energy storage accounts for a large portion of both lithium volumes and the value of lithium used globally. This demand stems primarily from both primary (disposable) and secondary (rechargeable) batteries. The energy storage market makes up roughly 20-25% of overall demand (by value) and has been growing in excess of 15%+ per year, driven by lithium use in consumer electronics and, more recently, in power hand tools.

Various lithium compounds including, lithium carbonate, lithium hydroxide, and lithium metal foil are sold directly to the battery industry. The lithium carbonate is the same across the marketplace but the quality and purity of the other two lithium compounds may vary across producers.

- *Primary batteries*—lithium batteries offer such advantages as 1) ability to function well in a wide temperature range, 2) a low self-discharge rate that enables a constant voltage to be delivered until the entire capacity is used up, and 3) a more

environmentally friendly battery due to the absence of toxic heavy metals such as mercury and cadmium. Due to its better performance, lithium batteries have displaced other primary batteries such as carbon/zinc, alkali/manganese, and zinc/silver oxide. Primary lithium batteries are currently used in military applications as well as back-up energy sources in industrial and commercial applications.

For those interested in the science/mechanics, the anodes of primary lithium batteries are manufactured from lithium metal while the cathode material contains manganese dioxide. The anode and the cathode are separated by microporous film soaked with an electrolyte that is made from a solution of a lithium salt such as lithium perchlorate, lithium tetrafluoroborate, and lithium trifluoromethylsulfonate.

- *Secondary batteries* (also called lithium-ion batteries)—lithium offers such advantages as greater power, improved service life, and the absence of “memory effect”. Lithium-ion batteries are widely used in cellular phones, portable computers, digital cameras, handheld devices (PDAs) and MP3s. They are also gaining use in power tools and prototype electric vehicles, and many battery manufacturers and automakers are working to successfully develop and commercialize lithium-ion battery usage in electric vehicles.

For those interested in the science/mechanics, the lithium anode in rechargeable batteries is replaced with another material that overcomes safety issues tied to the formation of highly reactive lithium dendrites that happens when charging a lithium anode. In lithium-ion batteries, the anode uses carbon instead, and allows the lithium to be intercalated into the carbon during the charging of the battery and de-intercalated from the carbon during the discharge of the battery.

The positive electrode of a lithium-ion battery contains a lithium metal oxide, carbon, and a polymer binder. The lithium metal oxides may be lithium cobaltate, nickelate, or manganate, and are made from lithium carbonate and the respective metal oxides.

The electrolytes in lithium-ion batteries may also contain lithium, in the form of lithium salts such as lithium hexafluorophosphate, lithium tetrafluoroborate, and lithium bis(trifluoromethyl) sulfonamide.

In the intermediate/long-term, we expect this market to see a significant pick up in demand for lithium tied to the auto market as HEV's shift over to lithium-ion batteries and PHEVs and EVs (which we believe will use lithium-ion batteries) start to penetrate the global auto market. We believe the hybrid electric vehicle market, which currently uses nickel-metal hydride batteries (NiMH), will gradually shift toward lithium-ion batteries as the technology improves and battery costs come down with the benefit of industry economies of scale. Regarding PHEVs and EVs, given their higher power needs, we believe they will use lithium-ion batteries (as NiMH batteries can't hold as much power) when those platforms ramp-up over the next few years.

With all of this in mind, we expect lithium demand from the battery industry to enjoy a CAGR of roughly 16% from 2009-2015 and 21% from 2009-2020. We believe the “traditional” energy storage demand tied to handheld devices will average roughly 10% with the auto industry accounting for higher growth rates owing to the penetration of electric vehicles in the out years.

Pharmaceutical Synthesis & Specialty Polymers (30% of global lithium market)

The pharmaceutical synthesis and specialty polymers markets combined make up roughly 30% of the overall lithium demand (by value) and we estimate that it is roughly split evenly between the two markets. The compound butyllithium, in which FMC and ROC have leading market positions, is primarily used in these end-markets.

In the pharmaceutical area, demand has been driven by continued growth in statin drugs (drugs that lower cholesterol levels in people with or at high risk of cardiovascular disease), anti-depressants as well as other pharmaceutical and agricultural fungicides. While demand tends to be lumpy based on customer order patterns and the timing of drug campaigns and new product launches, normalized demand growth for this market is in the mid-to-high single digits. Europe is the largest market for pharmaceutical synthesis sales while the emerging markets, particularly India, have been growing driven by generic drug demand.

The specialty polymers market uses lithium as a catalyst in manufacturing polymers in a variety of applications, such as elastomers in asphalt modification and adhesives, synthetic rubber in tire treads, and copolymer resins used in packaging. Asia represents half of the polymer demand with China becoming an increasingly important market. The specialty polymer market is expected to grow slightly higher than GDP rates.

Other Industrial Applications (45-50% of global lithium market)

A variety of industrial applications make up the remaining 50% of the lithium market. Examples of these industrial applications/end-markets include the glass and ceramic industries, industrial greases, aluminum, and air treatment. Given the specific end-markets, not surprisingly this portion of the market grows roughly in line with global GDP.

- **Glass/ceramics**—lithium is used in heat transfer applications, such as ceramic glass (used in kitchen cook tops) due to its high caloric capacity that enables it to withstand heat, make glass harder, and improve the appearance of its products. The vast majority of lithium consumed in the glass and ceramic industry comes from spodumene sources.
- **Metals**—in the steel industry, lithium is used in the continuous casting powder process where the liquid materials are solidified, as lithium allows for increased speed and fluidity in the molding process. Primary aluminum production accounts for roughly 4% of lithium demand, as lithium carbonate helps to improve the efficiency of aluminum smelters as well as provide environmental benefits from the reduction of fluorine emissions.
- **Greases**—the grease industry makes up the vast majority of lithium hydroxide demand. Lithium-based greases offer such advantages as the ability to retain lubricating properties over a wide range of temperatures, good resistance to water, oxidation, and hardening, and formation of a stable grease on cooling after melting. The greases are used in aerospace, automotive, industrial, military, and marine applications.

Global Capacity of Lithium Market

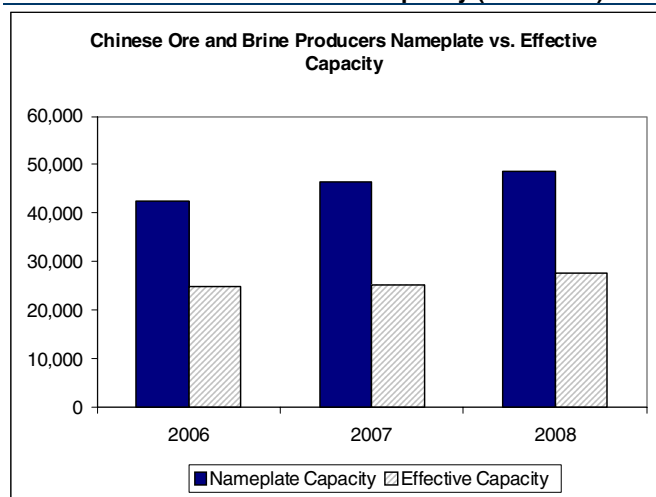
We estimate global nameplate capacity of the lithium market, as defined in lithium carbonate equivalent units (LCE units), to be roughly 129.5K metric tons as of the end of 2008. We estimate that SQM leads the market with roughly 31% of the market share, followed by Chemetall (owned by Rockwood) with 19% share and FMC with 12% share—all of this is low cost brine capacity with significant long-term reserves. The remaining 37% of the lithium market is primarily comprised of both brine-based (10%) and ore-based (27%) producers in China (Exhibit 5).

Exhibit 124: Estimated Nameplate Capacity as of Year-End 2008 and Announced Capacity Additions

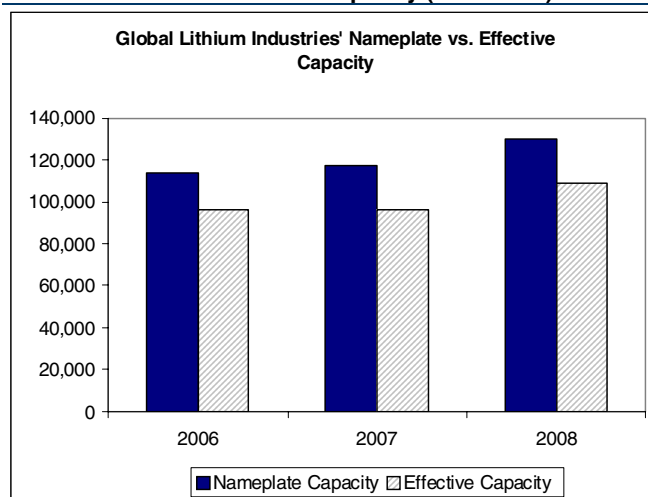
Estimated Nameplate Capacity (as of year-end 2008)						
Company	Source	Location	% of Global Lithium Capacity	Nameplate Capacity (LCE metric tons/year)	Recent and Expected Capacity Additions	Target Year for Expected Additions
FMC	Salar del Hombre Muerto	Argentina	12%	16,000	N/A	N/A
Rockwood (Chemetall)	Salar de Atacama	Chile	15%	20,000	N/A	N/A
	Silver Peak, Nevada	United States	4%	5,000	N/A	N/A
SQM	Salar de Atacama	Chile	31%	40,000	10,000	2008
Chinese Ore Producers						
Sichuan Tianqi Lithium	Shehong, Sichuan	China	8%	10,000	N/A	N/A
Xinjiang Non-ferrous	Urumchi Xinjiang	China	7%	9,500	N/A	N/A
Sichuan Ni&Co Guorun	Chengdu, Sichuan	China	3%	4,500	N/A	N/A
Aba Guangsheng	Aba, Sichuan	China	4%	5,000	N/A	N/A
Jixiang Lithium	Duijiangyan, Sichuan	China	3%	3,500	N/A	N/A
Pan-Asia (Nantong) Lithium	Ya'an, Sichuan	China	2%	3,000	N/A	N/A
<i>Sub-total</i>			<i>27%</i>	<i>35,500</i>		
Chinese Brine Producers						
Qinghai Guoan (CITIC)	Dongtai and Xitai	China	4%	5,000	25,000	2010
Tibet Mineral	Zabuye	China	4%	5,000	15,000	2011
Qinghai Salt Lake	Dongtai	China	2%	3,000	17,000	2010
<i>Sub-total</i>			<i>10%</i>	<i>13,000</i>	<i>57,000</i>	
Total			100%	129,500	67,000	

Source: Company data, Credit Suisse estimates

That said, owing to the technical, climatic and purity issues the Chinese producers are currently facing, we believe that the yields in the Chinese capacity are significantly less than implied by the nameplate capacity (especially for the brines producers). We estimate the Chinese ore and brine producers effective capacity equated to roughly 27.5K metric tons compared with the 48.5K metric tons of nameplate capacity in 2008. As a result, we believe the industry had a closer “real” capacity level of 108.5K metric tons as of the end of 2008 instead of 129.5K metric tons (or 16.2% less).

Exhibit 125: Chinese Producers Capacity (LCE units)

Source: Company data, Credit Suisse estimates

Exhibit 126: Global Lithium Capacity (LCE units)

Source: Company data, Credit Suisse estimates

Below, we have included a summary of all of the major producers, their supply/production capabilities, issues etc. that support the above statements/thoughts.

SQM

Sociedad Quimica y Minera de Chile S.A. (SQM) is a Chilean company that primarily makes potassium chloride, specialty plant nutrients, iodine and lithium. In the lithium business, SQM produces lithium carbonate, lithium hydroxide and lithium chloride that makes up roughly 10% of total company sales or roughly \$172 million in 2008. SQM is the

largest lithium carbonate producer globally and is a market leader in the production of lithium carbonate. With its significant scale and its vast brine reserves, we believe SQM is the lowest cost producer on a global basis.

SQM entered the lithium carbonate market, in 1996/1997. At that time, SQM's entry into the market caused a dramatic oversupply resulting in significant pricing pressure that forced many ore producers to exit the market—over that period prices dropped from roughly \$3,000/ton to less than \$2,000/ton. However by the end of 2007, the industry had more than recovered with lithium carbonate prices higher than \$4,000/ton (contract prices), driven by strong demand mainly from the construction and battery markets.

With regard to capacity, SQM has roughly 40K metric tons of lithium carbonate capacity (as well as additional lithium hydroxide capacity)—this includes 8K metric tons of prior production that has currently been idled as well as 12K metric tons of new capacity that SQM hadn't yet brought to the market (although that has changed with the recent announcement that SQM is dropping prices by 20% to drive demand (and we believe maintain market share)).

The company's facilities are tied to the Salar de Atacama brines located within the Atacama Desert near the Andes Mountains. The brines cover roughly 2,900 square kilometers and are contained in porous sodium chloride rock that is fed by water from the sub soil of the Andes. The brines contain varying concentrations of potassium, lithium, sulfates, and boron. SQM has a long-term contract with the Chilean government (specifically the Corporation for the Advancement of Production, a government entity) that gives the company production rights to the brine until 2030. From these brines, SQM produces potassium chloride, lithium carbonate, lithium hydroxide, potassium sulfate, boric acid, and bischofite (magnesium chloride).

FMC

FMC is another one of the large brine producers with mineral rights to the Salar del Hombre Muerto lithium reserves in Argentina. In exchange for the rights, the company pays an annual lease fee and a royalty tax based on sales. We estimate that the current capacity at this site is 16K metric tons of lithium carbonate equivalent units (including 4.7K tons of lithium chloride). According to the company, it has the ability to significantly increase its capacity with relatively minimal capital investment in an 18-24 months period—the time required to bring on the equipment and get through the evaporation time. To support this claim, FMC claims that they have sufficient reserves to support current levels of production for the next 70-100 years.

Roughly 8% of FMC's revenues in 2008 came from their lithium business with roughly 30% tied to the high value pharmaceutical industry, another 40% linked to the energy storage (battery) industry and the remainder from industrial markets. The company used to have a heavier weighting in the commoditized end of the lithium market (i.e. lithium carbonate) but chose to exit that business when SQM entered the market in the late 1990s and caused significant pricing declines. Today, FMC uses most of its lithium carbonate production internally to make downstream or specialized lithium compounds although it does sell some of its lithium carbonate into the merchant market.

In terms of operations, FMC has its main platform in Minera del Altiplano (Argentina), where it produces lithium chloride and lithium carbonate. The company also has operations in the U.S. and in the U.K., producing a full range of downstream compounds, lithium metal and organic lithium compounds. Finally, the company brought on a new butyllithium plant in India in early 2007 that will focus on pharmaceutical applications and a plant in China in the second half of 2008 that will serve the specialty polymer market.

ROC

Under its subsidiary Chemetall, Rockwood has a fully integrated platform in lithium from low-cost brine reserves, giving them the ability to make lithium carbonate as well as a host of high value downstream products including: lithium hydroxide, lithium nitrate, lithium

chloride, butyllithium, and lithium aluminum hydride. ROC utilizes most of its lithium carbonate production internally to make downstream products; however, it does sell a portion of its production into the merchant market. The lithium business accounted for roughly 17% of ROC's revenues in 2008 with 75-80% tied to higher value downstream products and 20-25% tied to the more commodity grade upstream products.

With regard to its facilities, Chemetall has its main operations in Chile and the U.S.:

- **Chile**--In Chile, Chemetall operates in the Salar de Atacama (the same as SQM) and produces lithium carbonate and lithium hydroxide. ROC's current lithium capacity in Chile equates to roughly 20K metric tons. The company has a long-term contract with the Chilean government whereby it pays a fixed royalty to the government, giving it access rights to lithium brine in the Atacama Desert (Salar de Atacama)—management estimates the supply is sufficient to last at least 50 years.
- **U.S.**--In the U.S. ROC produces lithium carbonate and lithium hydroxide at its U.S. brine reserves in Nevada, which have roughly 5K metric tons of capacity, with plans for an additional 5K metric tons that have temporarily been put on hold given the weak demand environment. ROC's lithium production/reserves in Nevada, which have higher production costs than its operations in Chile have recently been used as ROC's "swing" capacity to neutralize the impact of events such as wet weather in Chile or the sluggish demand currently being seen (this capacity is currently idled).
- The company also produces butyllithium at a Tennessee facility and downstream lithium compounds in North Carolina.

China

Currently, there is a large focus on China and its potential capacity for lithium production. Based on nameplate capacity data, between brine and ore producers, the Chinese have production capacity of roughly 48.5K metric tons of capacity, which would account for 37% of the global lithium market in 2008. However, based on our industry contacts/sources we believe that this capacity is significantly overstated, particularly by the brine producers and is closer to 27.5K metric tons. Longer-term, we believe that China has great potential to produce large quantities of lithium carbonate, although we don't expect it to flood the market in the near-term and only expect effective capacity to gradually ramp-up as the large brine producers resolve the technical and logistical production issues.

Chinese Ore Producers (mineral converters)

China became a large producer of lithium compounds through its ore platform as the producers convert spodumene, produced domestically and imported from Talison Minerals in Australia, to lithium compounds. China's strong demand for low grade spodumene (used as a raw material for lithium carbonate production) caused production of spodumene in Australia to more than quadruple between 2004 and 2006.

According to our industry sources, there are currently six Chinese ore producers with a total nameplate production capacity of roughly 35.5K metric tons of LCE units, although we believe the current effective capacity is closer to 27.5K tons (as of 2008). The producers and their nameplate capacity can be seen in Exhibit 8.

Exhibit 127: Chinese Ore Producers Nameplate Capacity (LCE units)

Chinese Ore Producers			
Company	Source	Nameplate	% of Global Lithium
		Capacity (LCE metric tons/year)	Nameplate Capacity
Sichuan Tianqi Lithium	Shehong, Sichuan	10,000	8%
Xinjiang Non-ferrous	Urumchi Xinjiang	9,500	7%
Sichuan Ni&Co Guorun	Chengdu, Sichuan	4,500	3%
Aba Guangsheng	Aba, Sichuan	5,000	4%
Jixiang Lithium	Dujiangyan, Sichuan	3,500	3%
Pan-Asia (Nantong) Lithium	Ya'an, Sichuan	3,000	2%
<i>Sub-total</i>		<i>35,500</i>	<i>27%</i>

Source: Company data, Credit Suisse estimates

When thinking of the Chinese ore producers, it is important to remember that ore producers are typically the high/marginal cost producers given the high cost of the raw materials and production/processing costs. With this in mind, the ore producers have acted as “swing” producers. For example in the late 1990s with the start of SQMs significant low cost brine production, many of the ore producers left the market as prices were below their costs to produce. However, in the middle of this decade when lithium battery demand was more robust than the brine producers capacity could accommodate, the ore producers returned to the market. Given their high cost of production, the fact that these marginal-cost producers returned to the market, resulted in significant profitability for the brine producers given the steepness of the cost curve.

Looking forward, given their high cost position and the expected ramp-up of further brine capacity both by the Lithium Three and Chinese producers, we don't expect much capacity expansions by the Chinese ore producers.

That said, given the weak demand and significant incremental capacity potentially coming on from the brine producers (especially in China), it will be important to monitor the supply/demand balance and whether these higher cost Chinese ore producers remain in the market—which would help to keep pricing high throughout the industry.

Chinese Brine Producers

In the early 2000's, after the successful development of specific extraction technology, the Chinese were finally able to focus on lower cost brine production with production focused on the reserves in the Qinghai and Tibet provinces of China.

Based on the data from one of our industry contacts, there are three major lithium brine producers in China with roughly 13K metric tons of nameplate capacity in 2008 (Exhibit 9) Additionally, the producers expect to bring on an incremental 57K metric tons of capacity between now and 2011.

Exhibit 128: Chinese Brine Producers Nameplate Capacity (LCE units)

Chinese Brine Producers					
Company	Source	Nameplate	% of Global	Recent and	Target Year
		Capacity (LCE metric tons/year)	Lithium Nameplate Capacity	Expected Capacity Additions	for Expected Additions
Qinghai Guoan (CITIC)	Dongtai and Xitai	5,000	4%	25,000	2010
Tibet Mineral	Zabuye	5,000	4%	15,000	2011
Qinghai Salt Lake	Dongtai	3,000	2%	17,000	2010
<i>Sub-total</i>		<i>13,000</i>	<i>10%</i>	<i>57,000</i>	

Source: Company data, Credit Suisse estimates

China started its production of lithium from brines at the Zabuye salt lake in Tibet and the Xitai and Dongtai salt lakes in Qinghai.

- Zabuye—the Zabuye salt lake has a lower lithium concentration than the Salar de Atacama (ROC and SQM) and Salar de Hombre (FMC). However it also has lower magnesium content, possibly resulting in lower purifications costs for lithium carbonate production.

Currently, we believe the production from the region is anemic given that the altitude of the Zabuye salt lake makes solar evaporation, especially in the winter months nearly impossible. However, our sources indicate that a new process has been developed that uses alternative freezing and solar evaporation to concentrate the brine and extract the lithium. While there has been rumored success in the summer months, it is still too early to tell if commercially viable lithium is produced during the winter months.

- Qinghai—the biggest issue with the lithium brines in this region is their purity levels. With a much higher magnesium:lithium ratio, the extraction and purification process is more difficult/costly. Additionally, they have a high chlorine level that currently hinders the product from being commercially viable. As a result, production levels are minimal in this region as well. However, in speaking with a number of experts/competitors, most believe it is only a question of when (not if) as to the timing of the Chinese improving their purification/upgrading technology to get higher purity grades.

All of this leads us to believe that between purity issues, seasonal issues (as much of the capacity is in regions that can't produce during the winter months for weather/evaporation issues) and capacity/production issues that the brine producers in China currently have an effective capacity that equates to less than 1K metric ton.

We remain very skeptical with regard to the current capacity and the potential for increases in production over the next 1-3 years given the aforementioned concerns and have modeled a much lower production rate in the near/intermediate term. However, we believe that over time the Chinese brine producers may become a sizable participant in the global market as they improve their process technology over the next 3-5 years. It will be important (albeit difficult) to monitor this capacity in the coming years as it may have a significant impact on the supply/demand balance and the steepness of the cost curve.

“Other” Capacity

In addition to the Lithium Three and the Chinese producers, there are a host of other projects/producers with plans for entering the lithium market. We remain skeptical, given the relative lack of experience and/or other risks that these projects will bare fruit even in the intermediate term, but they must be monitored because, given their potential size and/or cost position, they could have an impact on the long-term global capacity and supply/demand outlook. These projects include:

- The Sentient Group, a Private Equity firm, acquired the lithium operations of Rincon Lithium Ltd., which had the rights to a multi-elemental brine in Salar de Rincon in Argentina. Originally, Rincon estimated that it had capacity to produce 10K metric tons of lithium carbonate. The Sentient Group is currently in the evaluation/pilot plant phase of production with commercial development expected to start in 2011/2012.
- In mid 2008, the Bolivian government announced that it has approved the development of a new lithium pilot plant in the Salar de Uyuni in Bolivia, the largest salar in South America. The pilot plant will be operated by Corporacion Minera de Bolivia (Comibol), the state mining company.
- Galaxy Resources completed a feasibility study on its Mount Cattlin Spodumene project in Australia to produce lithium carbonate from spodumene and recently secured financing for the project. Construction of spodumene concentrate is scheduled to start in 2009 with first production in late 2011/2012 and total

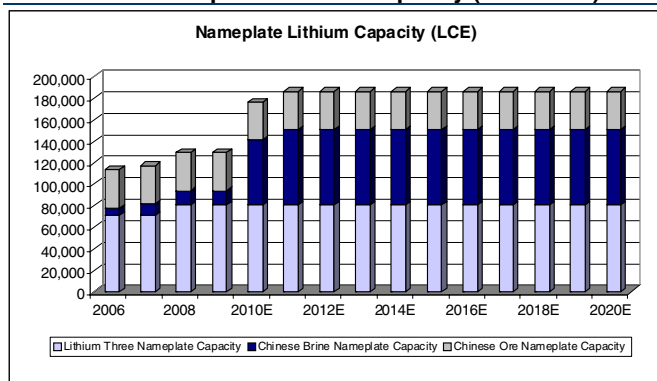
capacity expected to reach a significant 18K metric tons of LCE units when the plant is complete.

- Keliber Resources in Finland was sold to Nordic Mining in late 2008 but had originally been progressing with a feasibility test on the Lantta project in Finland to produce lithium carbonate from spodumene with potential capacity of 3K metric tons of LCE units. The Lantta project is still under feasibility testing under Nordic Mining and as such commercial production will probably be pushed back to 2011/2012.
- Orocobre Ltd, an Australian mineral exploration company announced plans to start lithium and potash production in Argentina by 2011. The company plans to mine lithium from salt flats in Argentina's northwest Jujuy province and stated that they can have 35K metric tons of annual capacity by 2011.
- Western Lithium is currently working on developing the reserves for their Kings Valley Lithium Project in Nevada. The company estimates they will have 96K metric tons of LCE capacity. Recently, the company commenced stage II drilling for the project and plans to raise \$16.6 million in private placement funding to support ongoing engineering and studies for their lithium project.
- Sterling Group Ventures of Canada's development of Jaijika spodumene deposits (that has roughly 1.03 million metric tons of lithium oxide reserves).
- Canada Lithium is currently testing the feasibility of several spodumene deposits in Quebec Canada and is exploring for lithium brine deposits in Nevada.

Capacity Outlook

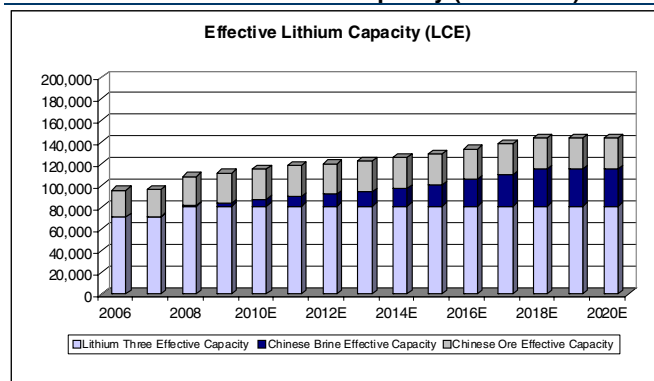
Looking forward we believe the industry will have enough supply to meet the growing demand (see pages 24-27). Simply based on current capacity from the Lithium Three and the Chinese producers, we estimate the industry will increase nameplate capacity from 129.5K metric tons in 2008 to 186.5K by 2020. More importantly, adjusted for seasonal issues for the China capacity as well as our belief that it will take the Chinese brine producers longer to get the capacity up and purity levels right than they have indicated (we assume all three players hit their capacity targets by 2017) we expect total effective capacity will move from 108.5K metric tons to 129K metric tons by 2015 and 143.7K metric tons by 2020.

Exhibit 129: Nameplate Lithium Capacity (LCE units)



Source: Company data, Credit Suisse estimates

Exhibit 130: Effective Lithium Capacity (LCE units)



Source: Company data, Credit Suisse estimates

It is also important to note that the aforementioned capacity equates only to current and announced capacity for the Lithium Three and the Chinese producers. We believe there is likely to be additionally capacity brought on over the next 5-6 years:

- Lithium Three—given the significantly lower cost reserves, and the player's incumbent position in the market, we believe they will likely bring on additional

capacity well before the industry sees any possible shortage in supply. Our proprietary sources have indicated the Lithium Three can increase their capacity by 25% (or ~ 20K metric tons) for a mere \$40-50 million in a 1-2 year time frame. Additionally, each of these companies have expressed an ability and/or desire to bring on significantly more capacity from their low cost reserves—for example ROC has indicated that if the demand is there they could increase their capacity from 25K+ metric tons in 2008 to 50K+ metric tons in 2020.

Finally, in the event the Lithium Three were to attempt to simply maintain their market share in the industry they would need to bring on a minimum of 45-70K tons by 2020 assuming the industry grows to meet overall demand.

- Chinese brine producers—with a focus on self-sufficiency with relatively low cost lithium, the Chinese brine producers have “announced” rapid expansion in brine production from 7K metric tons in 2006 to a target of 70K tons by 2011. While we don’t believe they will have that level of production up on schedule nor have they developed a process to improve quality levels, when that comes (and industry experts believe it will in the next few years) we would expect the industry to announce further capacity increases.
- Other—as we highlight on page 16, in addition to the Lithium Three and the Chinese producers, there are a number of projects that have been announced (both brine and ore projects). Given the lack of experience, lack of infrastructure, etc. it is difficult to know when/if any of these will come on. However, inevitably some of these announced projects (and some not announced yet) will eventually be successful.

Demand Outlook for Lithium

When looking at the lithium industry we have seen volume growth of over 8.5% over the past five years driven by: industrial production, increased use in pharmaceuticals and most importantly demand from rechargeable batteries for handheld devices, power tools etc. Only in 2009 with the significant global recession did we see a drop in volumes (we estimate roughly 20%). Looking forward to 2009-2015 we believe the lithium industry will see relatively strong growth of 7.2%, albeit not quite up to the levels seen over the past five years. As we expect growth to accelerate in the out years with incremental demand tied to the auto industry, we believe the CAGR from 2009-2020 will equate to 10.3%.

Demand for lithium will be driven by stable mid-single digit growth from the traditional lithium markets (pharmaceuticals, greases, rechargeable batteries for handheld devices, etc.) with significant additional demand tied to the auto industry shifting its HEVs to lithium batteries as well as the emergence of PHEVs and EVs.

Exhibit 131: Demand from Traditional Markets and Electric Vehicles (LCE units in metric tons)

	2006	2007	2008	2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E	2019E	2020E
Demand from Traditional Markets	76,000	82,000	85,000	68,000	72,760	77,126	80,982	85,031	89,283	93,747	98,434	103,356	108,523	113,950	119,647
Demand Growth from Traditional Markets		7.9%	3.7%	-20.0%	7.0%	6.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Demand from Electric Vehicles	0	0	0	41	247	1,059	2,167	3,843	6,484	9,469	18,699	38,153	58,281	63,960	81,090
Total Demand	76,000	82,000	85,000	68,041	73,007	78,184	83,149	88,874	95,766	103,216	117,133	141,509	166,804	177,910	200,737
Total Annual Growth		7.9%	3.7%	-20.0%	7.3%	7.1%	6.3%	6.9%	7.8%	7.8%	13.5%	20.8%	17.9%	6.7%	12.8%

Source: Company data, Credit Suisse estimates

Demand from Traditional Lithium Markets

As seen above in Exhibit 12, we expect lithium demand from the “traditional” markets (excluding HEV/PHEV/EVs) from 2009 through 2015 and 2020 to see a CAGR of approximately 5.5% and 5.3% respectively. This growth will be driven by:

- Energy storage devices—over the past few years this segment of the market has driven mid-teens+ volume growth stemming from handheld device demand and the shift of power tools from plug-ins to lithium batteries. We believe this growth will moderate over the next few years but still remain in the low-double digits.

- Pharma and specialty polymers—we expect this business to continue to enjoy mid to high-single digit growth driven by continued drug development as well as increased production of generics on a global basis.
- Industrial applications—we believe this broad segment of the lithium market that includes glass, ceramics, industrial greases, metal production, etc will grow at levels roughly in line with global GDP given the broad applications.

While our mid-single digit growth outlook going forward is slightly more modest than the levels seen throughout most of the decade, we believe it is appropriate given that the shift of the energy storage market for handheld devices from NiMH to lithium has largely been completed and the power tool market has already partially shifted to lithium batteries as well.

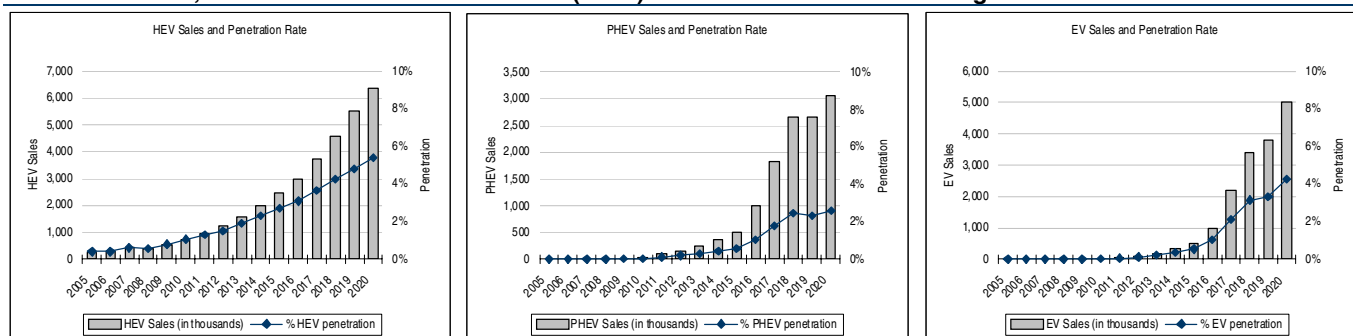
Incremental Demand from the HEV, PHEV and EV Markets

In addition to the mid-single digit growth expected through the next decade tied to the traditional lithium markets, we believe there will be significant incremental demand for lithium as the HEV market gradually shifts from NiMH batteries to lithium-ion batteries and as the PHEV and EV markets, which require lithium-ion batteries to meet their power needs, gain penetration in the global auto market. We believe the incremental lithium demand from the HEV/PHEV/EV market will grow from virtually zero demand currently to over 81K metric tons by 2020, which will help to drive total lithium demand from roughly 85K metric tons in 2008 to roughly 200K tons in 2020. This would result in a CAGR of 7.2% from 2009-2015 and 10.3% from 2009-2020 (as HEV/PHEV/EV penetration accelerates in the out years).

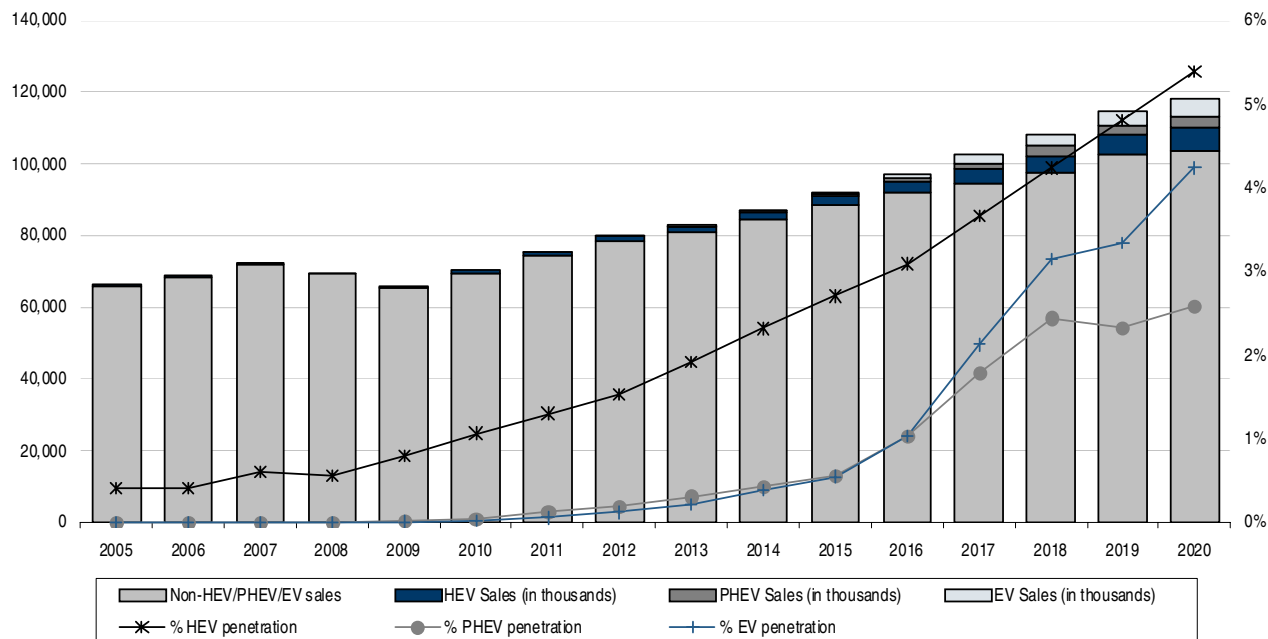
Forecasts for HEV/PHEV/EV Penetration Growth

The ultimate rate of HEV, PHEV and EV penetration in the auto market will likely depend on fuel costs and taxes, relative costs of electric vehicles compared to conventional vehicles, emissions regulations, battery costs, consumer preferences, and government subsidies. That said while there are clearly a number of moving parts that makes precise forecasting difficult, the Credit Suisse Alternative Energy team has developed a rough base-case scenario for HEV/PHEV/EV adoption rates based on an economic model, with various estimates for future oil prices, fuel taxes, battery costs and electricity costs among others. There is also an interactive model available that allows clients to modify assumptions and arrive at their own forecasts for penetration rates and the ultimate impact on lithium carbonate demand (please contact your Credit Suisse representative to obtain a copy).

Exhibit 132: HEV, PHEV and EV Forecasted Sales (units) and Penetration Rates through 2020



Source: Credit Suisse Alternative Energy team

Exhibit 133: Summary of Forecasts: HEVs, PHEVs, and EVs (units) Still Represent a Small Portion of Vehicle Sales

Source: Credit Suisse Alternative Energy team

Evident above, in the base case scenario our team expects HEV/PHEV/EV penetration rates to gradually climb from 2009 through 2020 as follows:

- HEVs—our team expects HEVs to enjoy increased penetration in the global auto market from currently less than 1% (or roughly 400 vehicles) to roughly 5.5% by 2020 or 6.4 million vehicles.
- PHEVs—penetration rates for PHEVs in the auto market are expected to jump from virtually zero to close to 2.6% by 2020 or over 3 million vehicles.
- EVs—in the global auto market, EVs are expected to see penetration improve from virtually zero to 4.2% by 2020, which would equate to roughly 5 million vehicles.

In addition to the actual HEV/PHEV and EV penetration rates, there are additional issues to consider with regard to determining the overall incremental demand for lithium tied to the auto industry including: the use of NiMH vs. lithium and how much lithium will be needed for HEV/PHEV/EV batteries.

Lithium-ion (Li-ion) Batteries vs. NiMH Batteries for HEVs, PHEVs, and EVs

To date, all HEVs predominately use NiMH batteries, which are larger, heavier, and have a lower energy density than Li-ion batteries but are also cheaper (by roughly \$800). Based on our alternative energy's team conclusions, they don't believe the energy density and resulting weight savings (and subsequent fuel savings) are reasons alone for HEVs to switch from NiMH to Li-ion batteries. According to their calculation (more details in Appendix 1), the battery weight difference between using Li-ion vs. NiMH batteries for HEVs is only about 24 pounds which equates to a 0.55% improvement in fuel efficient. This additional fuel economy provides consumers a total undiscounted lifetime savings of roughly \$100.

Despite the economics not justifying a switch, a number of auto manufacturers including Mercedes and BMW still have plans to use Li-ion batteries for HEVs. While some of this may be justified by the fact that the additional cost for Li-ion batteries for high end luxury vehicles is less significant or that there are only a few NiMH suppliers (mainly Panasonic

and Sanyo), we believe that over-time as battery costs come down, and safety and battery life time concerns are resolved, HEVs will gradually switch to using Li-ion batteries. As such, we believe that in 2009, 1% of all HEVs will use Li-ion batteries and that penetration rate should improve to 27% by 2015 and 62% by 2020. We encourage you to see our interactive Lithium Supply/Demand model for a sensitivity of these assumptions on ultimate lithium carbonate demand (please contact your Credit Suisse representative to obtain a copy).

For PHEVs and EVs, Li-ion batteries are the clear choice since they need to go further on electric propulsion (HEVs run on electricity from the battery and then use gasoline for longer trips). Li-ion batteries have a significantly higher energy density, greater operating voltage and lower self-discharge than NiMH batteries. Since the batteries for PHEVs and EVs have the greatest need for power and are so much larger, the energy density is very important – the GM Volt for instance has a 400 lb Li-ion battery. As such, we assume that all PHEVs and EVs that come to the market will be run on Li-ion batteries.

Amount of lithium required for HEV, PHEV & EV batteries

Given that a Li-ion battery has not yet been successfully developed for commercial use in HEVs, PHEVs, or EVs the amount of lithium necessary for each battery is not yet certain. We estimate that a 1.2 KWh Li-ion battery used in an HEV will require 0.72 kg of lithium carbonate, based on 0.6 kg/KWh of LiCO₃ (lithium carbonate) content. For PHEVs, which will require a much larger battery given the incremental power needs (we estimate 10KWh vs. the 1.2KWh in an HEV) will require 6 kg of lithium carbonate. Finally, for EVs that will require a 20KWh Li-ion battery, we estimate they will require 12 kg of lithium carbonate owing to it being fully powered by a battery, without an internal combustion engine. As mentioned above, these amounts are not yet certain and estimates range from 0.5-3 kg of lithium content required for HEVs to 4-12 kg of lithium content for PHEVs and 10-18 kg of lithium content for EVs.

As a result, if roughly 500,000 HEVs were sold this year and they all used Li-ion batteries, they could require 250-1,500 metric tons of lithium carbonate, or roughly 0.2-1% of 2009's global nameplate capacity. If Li-ion penetration was to increase further as many believe will happen when Li-ion batteries are safe and cheap enough, and HEV production ramps up to 5,000,000 units, this could require 2,500-15,000 metric tons of lithium carbonate, or roughly 2-12% of 2009's global nameplate capacity (or 2-13% of our estimated effective capacity).

Exhibit 134: Lithium Content per HEV (LCE units in metric tons)

		Number of Hybrid Electric Vehicles						
		500,000	1,000,000	1,500,000	2,000,000	3,000,000	5,000,000	7,000,000
		Total Lithium Demand from HEVs (LCE in metric tons)						
Lithium Content per HEV	0.5 kg/HEV	250	500	750	1,000	1,500	2,500	3,500
	0.7 kg/HEV	360	720	1,080	1,440	2,160	3,600	5,040
	1.0 kg/HEV	500	1,000	1,500	2,000	3,000	5,000	7,000
	2.0 kg/HEV	1,000	2,000	3,000	4,000	6,000	10,000	14,000
	3.0 kg/HEV	1,500	3,000	4,500	6,000	9,000	15,000	21,000
		% of 2009 Nameplate Capacity						
	0.5 kg/HEV	0.2%	0.4%	0.6%	0.8%	1.2%	1.9%	2.7%
	0.7 kg/HEV	0.3%	0.6%	0.8%	1.1%	1.7%	2.8%	3.9%
	1.0 kg/HEV	0.4%	0.8%	1.2%	1.5%	2.3%	3.9%	5.4%
	2.0 kg/HEV	0.8%	1.5%	2.3%	3.1%	4.6%	7.7%	10.8%
	3.0 kg/HEV	1.2%	2.3%	3.5%	4.6%	6.9%	11.6%	16.2%

Source: Company data, Credit Suisse estimates

If production of PHEVs ramps up to roughly 200,000 units, given the greater amount of lithium required, it could require roughly an additional 800-2,400 metric tons of lithium carbonate or roughly 0.6-2% of 2009's global nameplate capacity just for PHEVs. If battery

costs drop over time and PHEV adoption increased to 2,000,000 units, this would require 8,000-24,000 metric tons of lithium carbonate, or roughly 6-19% of 2009's global nameplate capacity (or 7-22% of our estimated effective capacity).

Exhibit 135: Lithium Content per PHEV (LCE units in metric tons)

		Number of Plug-in Hybrid Electric Vehicles						
		200,000	400,000	600,000	800,000	2,000,000	3,000,000	4,000,000
		Total Lithium Demand from PHEVs (LCE in metric tons)						
Lithium Content per PHEV	4.0 kg/PHEV	800	1,600	2,400	3,200	8,000	12,000	16,000
	6.0 kg/PHEV	1,200	2,400	3,600	4,800	12,000	18,000	24,000
	8.0 kg/PHEV	1,600	3,200	4,800	6,400	16,000	24,000	32,000
	10.0 kg/PHEV	2,000	4,000	6,000	8,000	20,000	30,000	40,000
	12.0 kg/PHEV	2,400	4,800	7,200	9,600	24,000	36,000	48,000
		% of 2009 Nameplate Capacity						
	4.0 kg/PHEV	0.6%	1.2%	1.9%	2.5%	6.2%	9.3%	12.4%
	6.0 kg/PHEV	0.9%	1.9%	2.8%	3.7%	9.3%	13.9%	18.5%
	8.0 kg/PHEV	1.2%	2.5%	3.7%	4.9%	12.4%	18.5%	24.7%
	10.0 kg/PHEV	1.5%	3.1%	4.6%	6.2%	15.4%	23.2%	30.9%
	12.0 kg/PHEV	1.9%	3.7%	5.6%	7.4%	18.5%	27.8%	37.1%

Source: Company data, Credit Suisse estimates

As EVs ramp up, given that there is no internal combustion engine to support the vehicle an even greater amount of lithium is required to power the battery resulting in significant demand for Li-ion batteries. For example, if EVs ramp up to 2,000,000 units, this could require 20,000-36,000 metric tons of lithium carbonate, or roughly 15-28% of 2009's global nameplate capacity (or 18-32% of our estimated effective capacity).

Exhibit 136: Lithium Content per EV (LCE units in metric tons)

		Number of Electric Vehicles						
		200,000	400,000	600,000	800,000	2,000,000	3,000,000	4,000,000
		Total Lithium Demand from EVs (LCE in metric tons)						
Lithium Content per EV	10.0 kg/EV	2,000	4,000	6,000	8,000	20,000	30,000	40,000
	12.0 kg/EV	2,400	4,800	7,200	9,600	24,000	36,000	48,000
	14.0 kg/EV	2,800	5,600	8,400	11,200	28,000	42,000	56,000
	16.0 kg/EV	3,200	6,400	9,600	12,800	32,000	48,000	64,000
	18.0 kg/EV	3,600	7,200	10,800	14,400	36,000	54,000	72,000
		% of 2009 Nameplate Capacity						
	10.0 kg/EV	1.5%	3.1%	4.6%	6.2%	15.4%	23.2%	30.9%
	12.0 kg/EV	1.9%	3.7%	5.6%	7.4%	18.5%	27.8%	37.1%
	14.0 kg/EV	2.2%	4.3%	6.5%	8.6%	21.6%	32.4%	43.2%
	16.0 kg/EV	2.5%	4.9%	7.4%	9.9%	24.7%	37.1%	49.4%
	18.0 kg/EV	2.8%	5.6%	8.3%	11.1%	27.8%	41.7%	55.6%

Source: Company data, Credit Suisse estimates

Lithium S/D Balance and Pricing

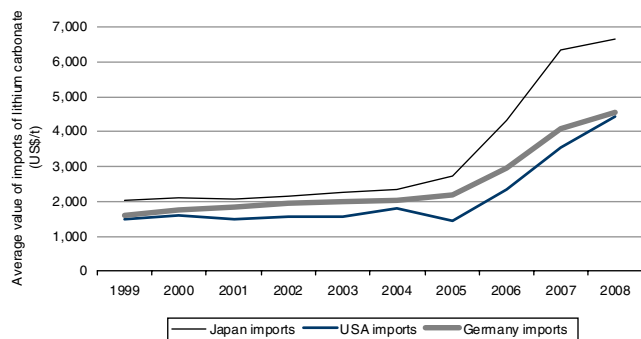
Based on the current capacity of the industry and the potential for more to come on over the intermediate to long-term, we believe that even with the auto industry likely driving significant demand for lithium, that the producers will have more than enough supply to meet demand barring any significant outages. As a result we don't expect pricing to move above the 2008 levels.

Historical Pricing

With regard to pricing, lithium carbonate purchases are typically tied to long-term supply contracts between the lithium producers and customers. As such, there is no spot market

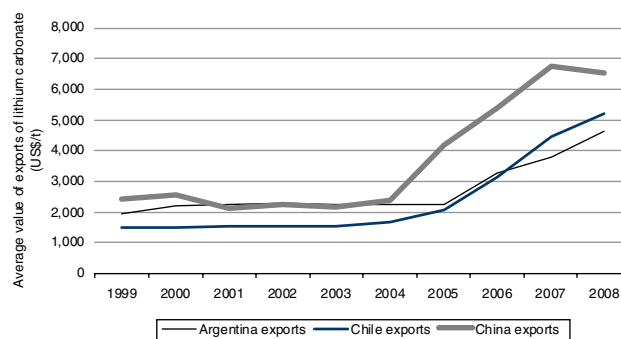
for lithium prices (producers negotiate with consumers on an individual basis). The Global Trade Atlas provides data on the average values of lithium carbonate exports from Argentina, Chile, and China and imports to Japan, USA and Germany measured in \$/ton, which when reviewed over time gives us a rough idea of how the pricing has trended. (Exhibit 18 & 19).

Exhibit 137: Average Value of Imports of Lithium Carbonate (US\$/t)



Source: Global Trade Atlas

Exhibit 138: Average Value of Exports of Lithium Carbonate (US\$/t)



Source: Global Trade Atlas

Entrance of brines loosened the market in the mid/late 90s...

As stated earlier, SQM entered the lithium market in 1996/97 with its low cost brine supply/capacity and as a result dramatically impacted pricing in the industry. SQM changed the structure of the lithium industry from high-cost lithium compound production based on minerals to low-cost large-scale brine-based production. Based on data from the USGS Minerals Yearbook, lithium carbonate prices decreased 27% from 1996-1997 and another 15% from 1997-1998 or from over \$3,000/ton to less than \$2,000/ton.

...but demand grew into capacity by 2006

In the mid 2000's lithium prices increased dramatically as demand outstripped brine capacity expansions, resulting in a return of the high-cost ore producers in China. The demand was driven by robust growth in the battery markets both tied to the Iraq war as well as handheld device demand. This resulted in a significant increase in prices from 2005-2008.

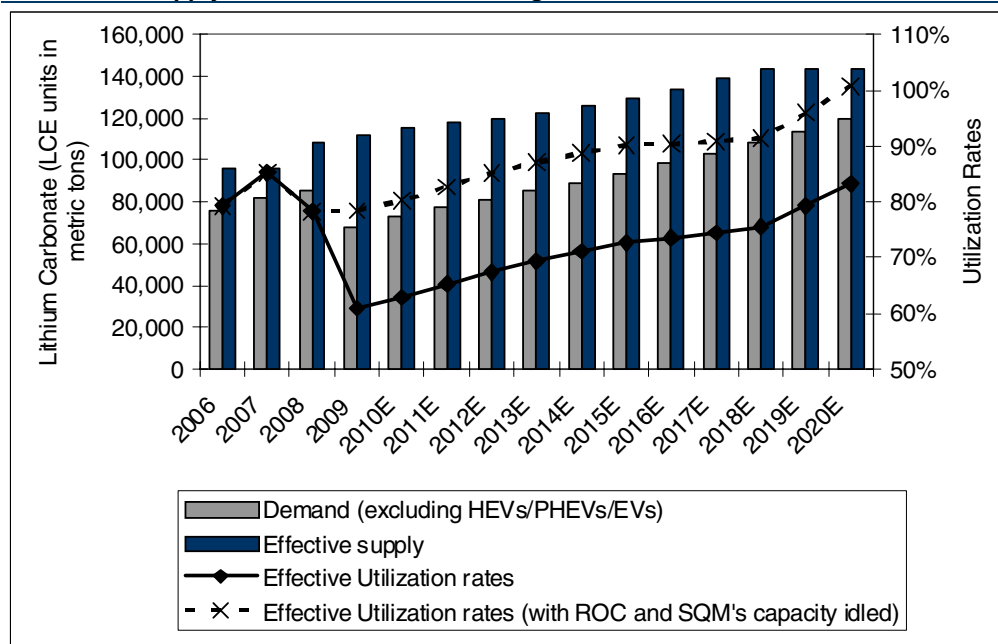
2009 pricing held up by discipline, but recent lapses should hurt 4Q09 and 2010

Currently lithium prices have remained relatively stable with the 2008 level of roughly \$5,000/ton despite what we estimate was a 20% drop in volumes as well as new capacity that came on in 2008/09. This surprise in pricing is strictly due to the discipline of two of the lower cost producers (SQM and ROC) who had idled and/or not brought on roughly 25K metric tons of capacity or ~20% of nameplate capacity. This discipline had helped to tighten effective utilization rates and maintain pricing for the majority of 2009.

However with SQM's announcement on 9/30/09, to reduce lithium prices by 20% for future contracts in an attempt to drive demand (and we believe share) and bring on all idled and off-line capacity, we expect prices to be under significant pressure. Given this lapse in discipline, we believe lithium carbonate pricing could be down 20% or more through 2010.

Supply/Demand Balance Very Loose Without Autos

Looking forward, given the industry's current capacity as well as plans for further capacity (discounted for those who are unproven, like the Chinese brine producers), in the event the auto industry doesn't see a big shift to lithium-ion powered cars (HEVs, PHEVs and EVs), we believe the industry will see utilization rates below 80% through 2020.

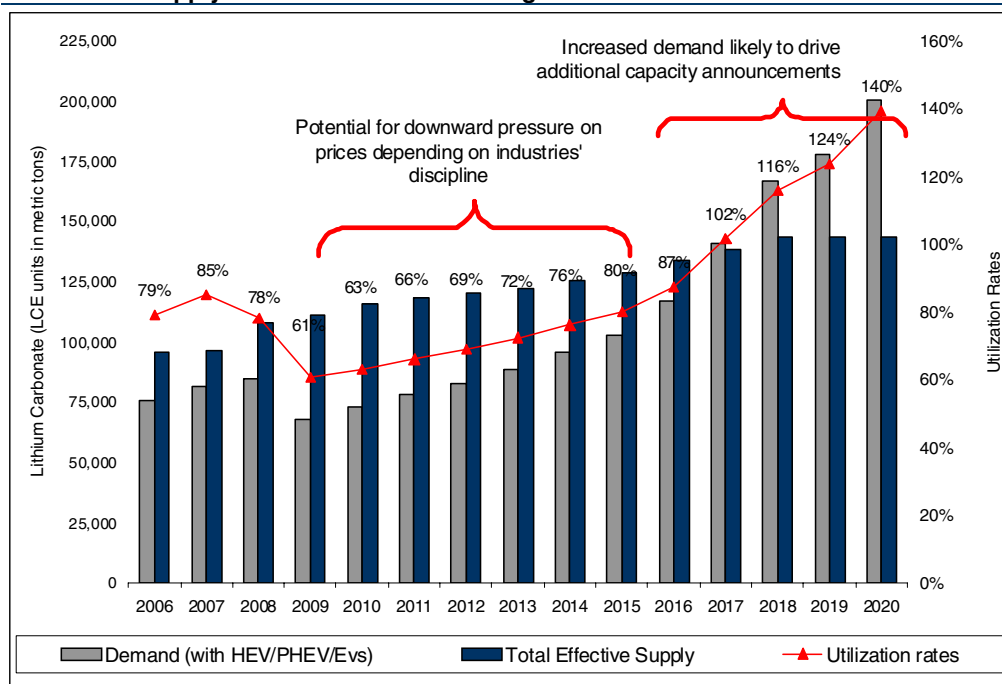
Exhibit 139: Supply/Demand Balance Excluding Demand from Electric Vehicles

Source: Company data, Credit Suisse estimates

Additionally, as we stated earlier, our effective capacity assumptions do not include any capacity expansion plans by the Lithium Three or Chinese producers, aside from their publicly announced expansion plans nor do they assume any of the “other” projects come on line, which is likely overly conservative.

HEV/PHEV/EVs Demand can be Met

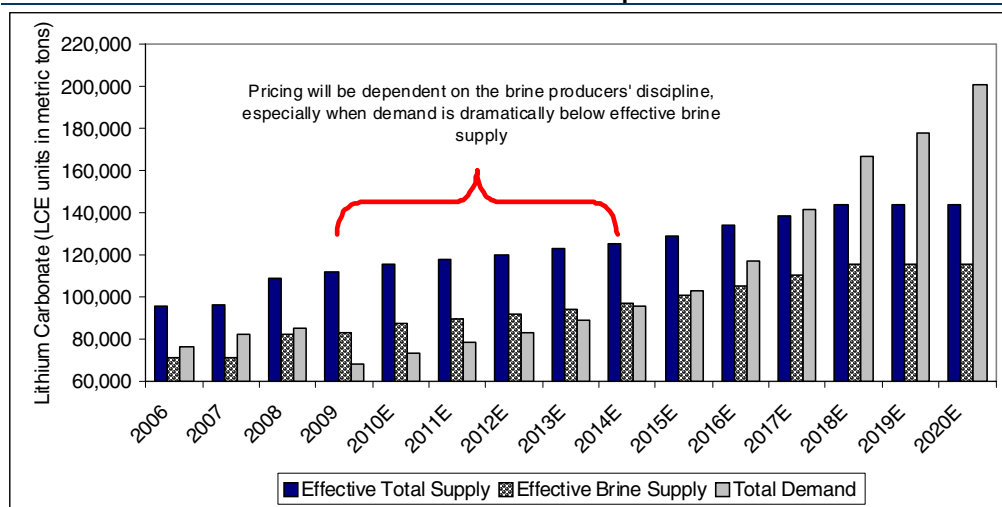
Based on our current supply model, assuming the auto industry ramps-up HEV, PHEV and EV production as expected over the next decade, we expect the supply/demand balance to tighten throughout the decade but the relative ease of further capacity additions should minimize/limit the potential for significant price increases above the 2008 levels.

Exhibit 140: Supply/Demand Balance Including Demand from Electric Vehicles

Source: Company data, Credit Suisse estimates

- Near/intermediate-term**—we expect the supply/demand balance to remain relatively loose through 2013/2014 with capacity utilization rates creeping up from 61% in 2009 to 76% by 2014 (see Exhibit 21). With utilization rates this low and SQM's recent move to improve demand/share through price cuts, we expect pricing to come under pressure – pricing had only held up through most of 2009 YTD because of near term discipline by ROC and SQM with idled capacity that SQM appears to be bringing back.

With SQM likely bringing/keeping all 40K metric tons of capacity on in the current weak demand environment, we believe pricing risk even relative to the announced 20% cut may be to the downside as there will be enough low cost brine capacity online to completely displace all of the high cost ore producers. As a result, with the marginal cost producers becoming brine producers, any further lapses in discipline or “cheating” to gain share could move prices back to the sub \$3,000/ton range (or 40% below recent prices).

Exhibit 141: Demand relative to brine and total lithium production

Source: Company data, Credit Suisse estimates

- **Longer-term**—given the aforementioned ramp-up in demand tied to the HEV, PHEV and EVs we expect the supply/demand balance to tighten throughout the decade with utilization rates at roughly the 80% range in 2015, demand exceeding supply by 2017 and by 2020 demand exceeding capacity by 40% (see Exhibit 21).

While that may sound like a dramatically improving scenario for lithium producers and an environment where pricing would be likely to improve, we would caution investors from getting excited. While the supply/demand balance in Exhibit 21 appears compelling in the latter part of the decade, it is important to note:

- 1) The Lithium Three—SQM, ROC and FMC have already stated that they could increase their capacity by roughly 25% or 20-25K tons with very limited capital (~\$40-50 million). As a result, there is a very high likelihood this capacity will come on by 2015/16 when the industry is tight enough to keep the ore producers in the market and the brine producers making robust profits/returns.

Additionally, in the event the Lithium Three work to maintain their current share of the market (a goal already stated by SQM) we could see significant capacity increases. Each of the producers has sizable untapped reserves and two of the three (FMC and SQM) have the balance sheet/capital to facilitate significant capacity increases in the near-term (and we believe ROC will by the time capacity is required). As a result, we could see these producers bringing on 45-70K tons to meet the incremental demand while maintaining their market share through 2020.

- 2) The Chinese brine producers—these producers have announced a number of large projects in the past few years with the goal of ramping up name-plate capacity from 13K tons in 2008 to 70K by 2111. These producers are clearly having significant issues with getting the capacity up along with the purity levels. However, we, industry experts and even some of their competitors believe it is only a matter of time before these issues are remedied. As the technical issues are remedied, we believe the Chinese brine producers will ramp-up additional capacity given the significant returns they should be capable of generating and the country's goal of meeting all of its demand with domestic production.
- 3) Other—in addition to the Lithium Three and the Chinese producers, there are a host of other projects/producers with plans for entering the lithium

market (see pages 16) including potential brine and ore projects. While our supply model doesn't include any of these, given the lack of experience and/or logistical/operating issues, it is likely that some of these projects will come on line and contribute to overall supply.

Appendix. Tax Credits & Incentives

The U.S. Stimulus Package

The U.S. Stimulus package strongly supports the PHEV market. The tax credit for taxpayers buying plug-in hybrids has been confirmed in the stimulus package signed by president Obama in February. The amount applicable for tax credits is the sum of \$2,500, plus \$417 for each kilowatt hour of traction battery capacity in excess of 4 kilowatt hours. The limit, however, for vehicles weighing up to 10,000 pounds is \$7,500. The two plug-in vehicles most likely first to hit the U.S. auto market in 2010, the Chevrolet Volt and the BYD F3DM, both have 16kWh batteries and are therefore applicable for the maximum amount of \$7,500. The limitation on number of passenger vehicles and light trucks eligible for the full tax credit has been increased from 200,000 to 250,000 per single manufacturer. Each automaker will get 100% of the credit for their first 200,000 vehicles, 50% credit for the next two quarters, and 25% credit for the final two quarters.

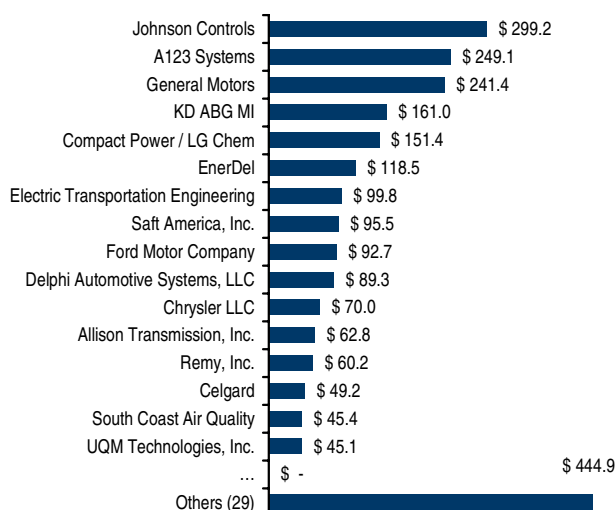
Beyond direct credits to consumers, the manufacturer of plug-in electric drive motor vehicles and components can also benefit from the stimulus package. Manufacturers may treat 100% (50% after Jan 1, 2012) of their cost of any qualified plug-in electric drive motor vehicle manufacturing facility property as an expense instead of depreciating the asset.

Exhibit 142: Stimulus Bill: \$14.4 billion for Plug-ins

Program	Support
Innovative Technology Loan Guarantee Program	\$6,000 million
Advanced Battery Manufacturing Grant	\$2,000 million
Plug-In Vehicle Tax Credits	\$2,000 million
Advanced Energy Investment Manufacturing Tax Credits	\$1,700 million
Automobile Purchase Sales Tax Credits	\$1,700 million
Infrastructure/Vehicle Deployment	\$400 million
Federal Purchase of High-Efficiency Vehicles	\$300 million
CleanCities Grant Support via DOE	\$300 million
Alternative Refueling Property Tax Credits	\$54 million
Advanced Technology Vehicles Manufacturer Loans	\$10 million
Total	\$14,464 million

Source: www.pluginamerica.org

Exhibit 143: Grant Recipients: \$2.4 billion in grants



Source: Department of Energy

Advanced Technology Vehicles Manufacturing Loan Program (ATVM)

The US Energy Independence and Security Act of 2007 established a large grant and loan program to support the development of advanced vehicles. The Department of Energy can provide up to \$25 billion in loans under the ATVM.

On September 22, 2009, Fisker Automotive received a \$538 million loan under this program to further develop and commercialize their plug-in hybrid electric vehicle. The loan will be given out in two stages, the first stage covering reengineering integration costs and the second stage supporting the development of their Project Nina model. Fisker has stated that the Nina vehicle could enter production of 75,000 to 100,000 vehicles per year by late 2012. The loan package is the fourth loan the US Department of Energy has awarded under the Advanced Technology Vehicles Manufacturing (ATVM) Loan program.

Earlier in the year the Department of Energy announced that three loans had been awarded to Ford, Nissan, and Tesla. Ford received a loan for \$5.9 billion to transform factories to produce more fuel efficient models, Nissan North America received \$1.6 billion

to build advanced electric automobiles and battery manufacturing facilities; and Tesla received \$465 to manufacture electric vehicles.

Michigan State Tax Credits

The State of Michigan has decided in April 2009 to grant over \$500 million in tax credits to battery manufacturers building plants in Michigan. The purpose of the incentives is to allow plug-in hybrid vehicle technology to become affordable and to create jobs. The following four projects have been granted tax credits:

Exhibit 144: Michigan Battery Projects

	Tax Credit	Project Capital	Jobs
A123Systems Inc. of Massachusetts	\$125.2 million	\$600 million	5,000
LG Chem of Korea / Compact Power Inc. of Troy	\$125.2 million	\$200 million	300
Johnson Controls-SAFT Advanced Power Solutions L.L.C.	\$148.5 million	\$220 million	498
KD Advanced Battery Group L.L.C.	\$144.6 million	\$665 million	885

Source: Company data, Credit Suisse estimates

Subsidies and Tax Credits for HEVs

The federal government provides income tax credits of up to \$3,400 for HEVs purchased or placed into service after December 31, 2005. This credit is only available to the original purchaser and demands that the vehicle is predominantly used within the United States. The distinction on the amount is made based on the vehicle's performance. E.g. the tax credit for 2WD vehicles is remarkably higher than for 4WDs. The credit amounts begin to phase out for a given manufacturer once it has sold over 60,000 eligible vehicles. We include a table of the credits in the appendix. Honda and Toyota hybrid vehicles are no longer eligible for federal tax credits. Also Ford models will be completely phased out in April 2010.

In addition to federal tax credits, several states and cities provide further incentives and rebates. They go from non-monetary benefits such as permission to drive solo in High Occupancy Vehicle lanes to parking fee discounts, vehicle tax rate deduction or state tax credits on new vehicles or conversions. Most benefit programs are limited to the first few thousand appliers and expire after the successful stimulation.

Appendix: Li vs. NiMH Batteries

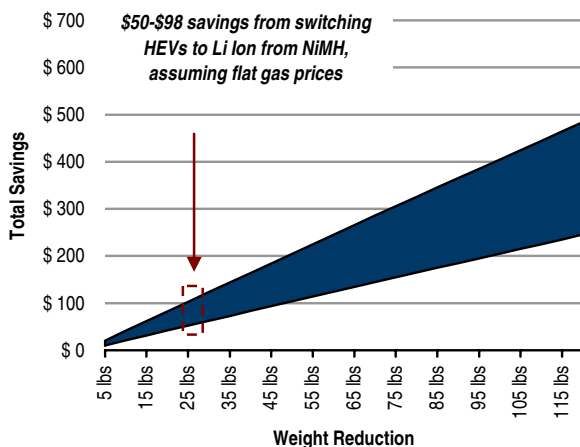
Hybrid electric vehicles predominantly use NiMH batteries while plug-in electric vehicles use lithium ion batteries. To date, nearly all major hybrid vehicles are equipped with nickel metal hydride batteries. Despite the lower energy density, NiMH has been the favored choice to store energy for HEVs.

Will NiMH batteries be replaced by Li-Ion chemistries, or will NiMH remain a major player in the HEV market? Mercedes and BMW have recently announced plans to produce HEVs with lithium ion batteries. Toyota and Honda, however, will be sticking with nickel metal hydride batteries, at least in the near term. They have stated that the current NiMH technology works great for hybrids and is safer, more reliable and cost effective than lithium batteries. The cost/benefit trade-off between NiMH and Li-Ion batteries for small hybrid batteries (~1.3kWh) is approximately \$800 (\$1,100 vs. \$1,900). In addition, there is still significant uncertainty about lifetime and safety of lithium batteries. NiMH batteries have a proven track record for longevity, as they remain useful after many charge/discharge cycles. So what is the reason for car makers like Mercedes and BMW to switch to lithium?

First of all, we don't think the energy density and the resulting weight gains are reasons alone to switch, as the battery weight difference for HEVs is only about 24 pounds. If a HEV used Li Ion instead of a NiMH battery, only 24 lbs would be reduced – equating to only a 0.55% improvement in fuel efficiency (from 50 to 50.27 MPG), according to our estimates. Our calculations are based on a Department of Energy's estimate that for every 10% of weight eliminated from a vehicle's total weight, the fuel economy improves by 7% percent. A linear regression would suggest a 0.0054 MPG improvement for every pound removed, resulting in a 0.13 MPG improvement, even lower than the 0.27 MPG improvement we assumed. While fuel economy improvements are never trivial, the improvement provides consumers a total undiscounted lifetime savings of only \$100 (and \$50 if discounted at 10%). Thus, Lithium Ion batteries for HEVs could only demand a premium of \$50-\$100/battery – current prices are significantly higher. These savings assume that gasoline is more than \$4/gallon, you drive 15,000 miles/year, and the vehicle lasts 15 years – all generous assumptions, in our opinion.

Exhibit 145: Savings with \$4 gas

Range shown represents the difference between net present value of savings (discounted at 10%) vs. simple total savings obtained from improved fuel efficiency resulting from weight savings.

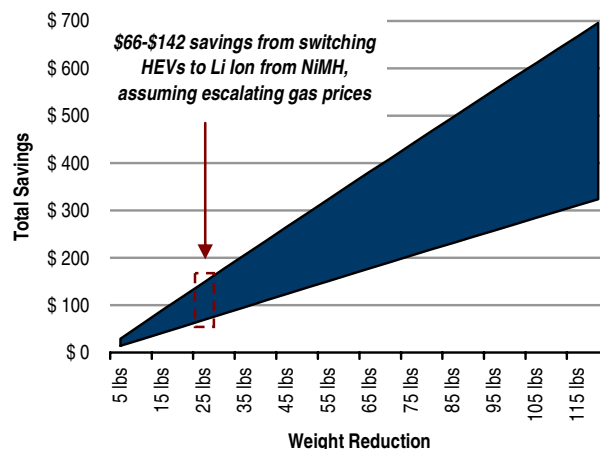


Source: Company data, Credit Suisse estimates

Note: Assumptions include 15 year vehicle life, 15,000 miles driven per year, 10% weight reduction equates to a 7% fuel economy improvement

Exhibit 146: Savings with \$4 gas escalating 5% per year

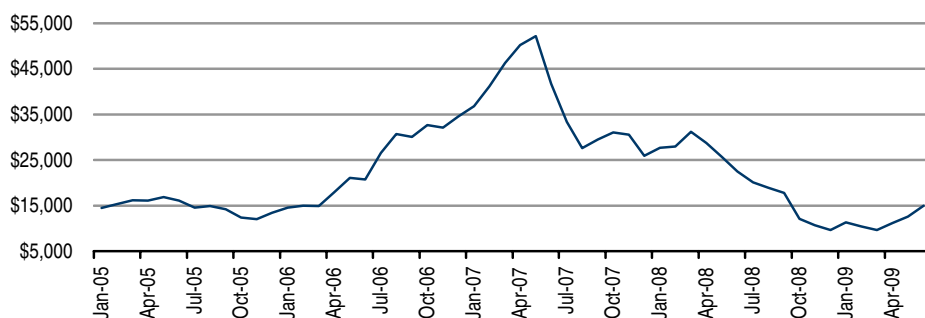
Range shown represents the difference between net present value of savings (discounted at 10%) vs. simple total savings obtained from improved fuel efficiency resulting from weight savings.



Source: Company data, Credit Suisse estimates

Note: Assumptions include 15 year vehicle life, 15,000 miles driven per year, 10% weight reduction equates to a 7% fuel economy improvement

Given the limited premium warranted for switching to Lithium Ion batteries for HEVs, why are Mercedes and BMW planning on using them, especially given the inherent risks associated with the unproven technology? Instead, we believe the additional cost of \$800 for Lithium batteries for high end luxury vehicles such as the Mercedes S Class and the BMW 7 Series is less significant when compared to the total vehicle cost of \$80,000 to \$100,000. Additionally, there are only a few NiMH suppliers. Panasonic and Sanyo are the only big players in the NiMH battery market. Panasonic, which is expected to make an offer to acquire Sanyo, is working in a joint venture with Toyota. It is conceivable that the partnership jeopardizes the impartiality other auto makers are seeking. Lastly, auto manufacturers are interested in progressing up the learning curve so they can potentially leverage lithium power systems in future PHEV and EV models.

Exhibit 147: Nickel Metal Prices (US\$/ton)

Source: FactSet

Even though the costs for NiMH batteries are volatile due to fluctuating nickel prices (see chart above), they appear to have reached trough levels. Lithium price, however, has been increasing. Current lithium carbonate prices are roughly \$3 per pound. The cost of lithium within a lithium ion battery is actually low. For example, with a 10 KWh PHEV battery, only ~6 kg of carbonate would be required, costing ~\$40 (<0.5% of the cost of the

battery). While pricing may continue to increase, there is ample lithium supply and production capacity can come online to meet the growing automotive battery market. The lithium supply chain and worldwide production estimates are detailed in a separate report, also published today.

Lithium Ion is the Clear Choice for Plug-in Hybrid Electric Vehicles

Lithium ion batteries have a significantly higher energy density, meaning more energy per kg of weight than most other storage technologies. Lithium ion has about three times the operating voltage, at least twice the energy density, and much lower self-discharge than NiMH batteries. Lithium ion batteries are being planned for the EVs and PHEVs (for example, the Chevy Volt) that will need to go further on electric propulsion. Hybrid vehicles, by comparison, initially run on electricity from the battery and then use gasoline for longer trips. That allows for a smaller battery and reduces the need for the more energy efficient lithium ion battery.

The following manufacturers are using lithium manganese spinel cathodes with a carbon anode. This chemistry gets an energy density of 80-90 Wh/Kg, which is lower than lithium phosphate:

- Compact Power Inc. (LG Chem)
- Nissan + NEC Corp (as Joint Venture called AESC)
- GS Yuasa + Mitsubishi (as Joint Venture called LEJ)
- Hitachi (no Joint Venture, but in talks with Subaru and Fuji for supplier agreement)

EnerDel (HEV) is also using a manganese spinel cathode, but in connection with titanate anode, which is a stable match but has a significantly lower energy density of 60-70 Wh/Kg. The chemistry itself is good, but might only be able to compete with nickel metal hydride batteries which only need a capacity of ~1.5kWh or less (or for grid-related applications). But, for this size, the existing nickel metal hydride technology is sufficient. The EnerDel chemistry could match the requirements for heavy duty hybrids which require high leveling power but low capacity. BYD is using a Lithium Ion Phosphate battery pack for their self produced vehicles.

Exhibit 148: Summary of Lithium Batteries

	Layered Transition Metal Oxide Cathodes $\text{Li}(\text{NiCoMn})\text{O}_2$, $\text{Li}(\text{NiCo})\text{O}_2$, LiCoO_2 etc.	Transition Metal Phosphate Cathodes LiFePO_4 , $\text{Li}_3\text{V}_2(\text{PO}_4)_3$	Lithium Manganese Spinel Cathodes LiMn_2O_4	Lithium Titanate Spinel Anodes $\text{Li}_4\text{Ti}_5\text{O}_{12}$
Strengths	-Small format -High energy and power density	-Moderately high safety -Inexpensive ingredients -Good power density	-High safety -Inexpensive ingredients -High calendar life potential	-Very high safety -Very high life cycle -Very high rate capability
Weaknesses	-Lower safety in larger format -Expensive ingredients (Nickel and Cobalt)	-Compactness	-Low life cycle -Poor performance at extreme temperature	-Low energy density -Potential high cost due to use of Titanium
Manufacturers	JCI-Saft	A123, LEJ, PHET, LifeBatt, Toshiba, BYD	AESC, Compact Power Inc., LG Chem	EnerDel, Toshiba, Altair- Nanomaterials

Source: E3BV, Company data, Credit Suisse estimates

That said, there is a possibility that we will see a resurgence of NiMH for parallel PHEVs. Cobasys, which is now owned by a joint venture between Bosch and Samsung, owns a significant patent for NiMH technology. In the past they have limited large-format use of the technology. Toyota was essentially forced to stop production of the RAV4-EV back in 2000. The NiMH patent expires in 2015. Recall that Ovonic Battery (part of Energy Conversion Devices) developed the technology in a JV called Cobasys, partly owned by Texaco, which then was acquired by Chevron. Cobasys was sold to Bosch and Samsung in July 2009.

Companies Mentioned (Price as of 30 Sep 09)

Asahi Kasei (3407, ¥457, NEUTRAL, TP ¥430, MARKET WEIGHT)
 Avex Group Holdings (7860, ¥833, OUTPERFORM, TP ¥1,600, MARKET WEIGHT)
 BMW (BMWG.F, Eu33.76, OUTPERFORM [V], TP Eu40.00, MARKET WEIGHT)
 BYD Co Ltd (1211.HK, HK\$63.85, OUTPERFORM [V], TP HK\$59.00)
 Casio Computer Co Ltd (6952, ¥733, OUTPERFORM [V], TP ¥900, MARKET WEIGHT)
 Daimler (DAIGn.DE, Eu34.30, OUTPERFORM [V], TP Eu40.00, MARKET WEIGHT)
 FMC Corporation (FMC, \$56.65)
 Ford Motor Co. (F, \$7.45, NEUTRAL [V], TP \$7.00)
 Funai Electric (6839, ¥4,100, NEUTRAL [V], TP ¥4,000, MARKET WEIGHT)
 Furukawa Electric (5801, ¥365, NEUTRAL [V], TP ¥390, OVERWEIGHT)
 GS Yuasa (6674, ¥820, UNDERPERFORM [V], TP ¥330, MARKET WEIGHT)
 Johnson Controls, Inc. (JCI, \$25.94, OUTPERFORM [V], TP \$26.00)
 Kureha (4023, ¥553, OUTPERFORM, TP ¥650, MARKET WEIGHT)
 LG Chem Ltd. (051910.KS, W219,000, NEUTRAL [V], TP W209,000)
 Magna International (MGA, \$42.92, NEUTRAL [V], TP \$45.00)
 Mitsubishi Chemical Holdings (4188, ¥373, NEUTRAL, TP ¥460, MARKET WEIGHT)
 Nidec (6594, ¥7,290, OUTPERFORM, TP ¥8,500, MARKET WEIGHT)
 Nintendo (7974, ¥23,000, NEUTRAL [V], TP ¥26,600, MARKET WEIGHT)
 ON Semiconductor Corp. (ONNN, \$8.07, OUTPERFORM [V], TP \$10.00)
 Panasonic Corporation (6752, ¥1,323, NEUTRAL, TP ¥1,600, MARKET WEIGHT)
 Pioneer Corporation (6773, ¥216, UNDERPERFORM [V], TP ¥137, MARKET WEIGHT)
 PSA Peugeot Citroen (PEUP.PA, Eu21.15, UNDERPERFORM [V], TP Eu20.00, MARKET WEIGHT)
 Renault (RENA.PA, Eu32.08, UNDERPERFORM [V], TP Eu30.00, MARKET WEIGHT)
 Rockwood Holdings Inc. (ROC, \$20.71, OUTPERFORM [V], TP \$22.00)
 Rohm (6963, ¥6,280, OUTPERFORM [V], TP ¥7,400, MARKET WEIGHT)
 Samsung SDI (006400.KS, W149,000, UNDERPERFORM [V], TP W127,000)
 Sanyo Electric (6764, ¥213, NEUTRAL [V], TP ¥220, MARKET WEIGHT)
 Sharp Corp. (6753, ¥998, RESTRICTED [V])
 Sony (6758, ¥2,655, UNDERPERFORM [V], TP ¥2,000, MARKET WEIGHT)
 Soquimich (SQM, \$39.09, UNDERPERFORM, TP \$30.00)
 TDK Corp (6762, ¥5,190, NEUTRAL [V], TP ¥5,000, MARKET WEIGHT)
 Ube Industries (4208, ¥236, OUTPERFORM [V], TP ¥360, MARKET WEIGHT)
 Volkswagen (VOWG_p.F, Eu78.20, OUTPERFORM [V], TP Eu69.00, MARKET WEIGHT)

Disclosure Appendix

Important Global Disclosures

I, Gary Balter, certify that (1) the views expressed in this report accurately reflect my personal views about all of the subject companies and securities and (2) no part of my compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

The analyst(s) responsible for preparing this research report received compensation that is based upon various factors including Credit Suisse's total revenues, a portion of which are generated by Credit Suisse's investment banking activities.

Analysts' stock ratings are defined as follows:

Outperform (O): The stock's total return is expected to outperform the relevant benchmark* by at least 10-15% (or more, depending on perceived risk) over the next 12 months.

Neutral (N): The stock's total return is expected to be in line with the relevant benchmark* (range of $\pm 10\text{-}15\%$) over the next 12 months.

Underperform (U): The stock's total return is expected to underperform the relevant benchmark* by 10-15% or more over the next 12 months.

*Relevant benchmark by region: As of 29th May 2009, Australia, New Zealand, U.S. and Canadian ratings are based on (1) a stock's absolute total return potential to its current share price and (2) the relative attractiveness of a stock's total return potential within an analyst's coverage universe**, with Outperforms representing the most attractive, Neutrals the less attractive, and Underperforms the least attractive investment opportunities. Some U.S. and Canadian ratings may fall outside the absolute total return ranges defined above, depending on market conditions and industry factors. For Latin American, Japanese, and non-Japan Asia stocks, ratings are based on a stock's total return relative to the average total return of the relevant country or regional benchmark; for European stocks, ratings are based on a stock's total return relative to the analyst's coverage universe**. For Australian and New Zealand stocks a 22% and a 12% threshold replace the 10-15% level in the Outperform and Underperform stock

rating definitions, respectively, subject to analysts' perceived risk. The 22% and 12% thresholds replace the +10-15% and -10-15% levels in the Neutral stock rating definition, respectively, subject to analysts' perceived risk.

****An analyst's coverage universe consists of all companies covered by the analyst within the relevant sector.**

Restricted (R): In certain circumstances, Credit Suisse policy and/or applicable law and regulations preclude certain types of communications, including an investment recommendation, during the course of Credit Suisse's engagement in an investment banking transaction and in certain other circumstances.

Volatility Indicator [V]: A stock is defined as volatile if the stock price has moved up or down by 20% or more in a month in at least 8 of the past 24 months or the analyst expects significant volatility going forward.

Analysts' coverage universe weightings are distinct from analysts' stock ratings and are based on the expected performance of an analyst's coverage universe* versus the relevant broad market benchmark:**

Overweight: Industry expected to outperform the relevant broad market benchmark over the next 12 months.

Market Weight: Industry expected to perform in-line with the relevant broad market benchmark over the next 12 months.

Underweight: Industry expected to underperform the relevant broad market benchmark over the next 12 months.

***An analyst's coverage universe consists of all companies covered by the analyst within the relevant sector.**

****The broad market benchmark is based on the expected return of the local market index (e.g., the S&P 500 in the U.S.) over the next 12 months.**

Credit Suisse's distribution of stock ratings (and banking clients) is:

Global Ratings Distribution		
Outperform/Buy*	38%	(57% banking clients)
Neutral/Hold*	42%	(59% banking clients)
Underperform/Sell*	17%	(48% banking clients)
Restricted	2%	

**For purposes of the NYSE and NASD ratings distribution disclosure requirements, our stock ratings of Outperform, Neutral, and Underperform most closely correspond to Buy, Hold, and Sell, respectively; however, the meanings are not the same, as our stock ratings are determined on a relative basis. (Please refer to definitions above.) An investor's decision to buy or sell a security should be based on investment objectives, current holdings, and other individual factors.*

Credit Suisse's policy is to update research reports as it deems appropriate, based on developments with the subject company, the sector or the market that may have a material impact on the research views or opinions stated herein.

Credit Suisse's policy is only to publish investment research that is impartial, independent, clear, fair and not misleading. For more detail please refer to Credit Suisse's Policies for Managing Conflicts of Interest in connection with Investment Research: http://www.csfb.com/research-and-analytics/disclaimer/managing_conflicts_disclaimer.html

Credit Suisse does not provide any tax advice. Any statement herein regarding any US federal tax is not intended or written to be used, and cannot be used, by any taxpayer for the purposes of avoiding any penalties.

Important Regional Disclosures

Restrictions on certain Canadian securities are indicated by the following abbreviations: NVS--Non-Voting shares; RVS--Restricted Voting Shares; SVS--Subordinate Voting Shares.

Individuals receiving this report from a Canadian investment dealer that is not affiliated with Credit Suisse should be advised that this report may not contain regulatory disclosures the non-affiliated Canadian investment dealer would be required to make if this were its own report.

For Credit Suisse Securities (Canada), Inc.'s policies and procedures regarding the dissemination of equity research, please visit http://www.csfb.com/legal_terms/canada_research_policy.shtml.

The following disclosed European company/ies have estimates that comply with IFRS: 3407, BMWG.F, DAIGN.DE, PEUP.PA, RENA.PA, VOWG_p.F.

As of the date of this report, Credit Suisse acts as a market maker or liquidity provider in the equities securities that are the subject of this report.

Principal is not guaranteed in the case of equities because equity prices are variable.

Commission is the commission rate or the amount agreed with a customer when setting up an account or at anytime after that.

CS may have issued a Trade Alert regarding this security. Trade Alerts are short term trading opportunities identified by an analyst on the basis of market events and catalysts, while stock ratings reflect an analyst's investment recommendations based on expected total return over a 12-month period relative to the relevant coverage universe. Because Trade Alerts and stock ratings reflect different assumptions and analytical methods, Trade Alerts may differ directionally from the analyst's stock rating.

The author(s) of this report maintains a CS Model Portfolio that he/she regularly adjusts. The security or securities discussed in this report may be a component of the CS Model Portfolio and subject to such adjustments (which, given the composition of the CS Model Portfolio as a whole, may differ from the recommendation in this report, as well as opportunities or strategies identified in Trading Alerts concerning the same security). The CS Model Portfolio and important disclosures about it are available at www.credit-suisse.com/ti.

To the extent this is a report authored in whole or in part by a non-U.S. analyst and is made available in the U.S., the following are important disclosures regarding any non-U.S. analyst contributors:

The non-U.S. research analysts listed below (if any) are not registered/qualified as research analysts with FINRA. The non-U.S. research analysts listed below may not be associated persons of CSSU and therefore may not be subject to the NASD Rule 2711 and NYSE Rule 472 restrictions on communications with a subject company, public appearances and trading securities held by a research analyst account.

- Adrian Chan, non-U.S. analyst, is a research analyst employed by Credit Suisse (Hong Kong) Limited.

- Arndt Ellinghorst, non-U.S. analyst, is a research analyst employed by Credit Suisse Securities (Europe) Limited.
- Stuart Pearson, non-U.S. analyst, is a research analyst employed by Credit Suisse Securities (Europe) Limited.
- Jun Yamaguchi, non-U.S. analyst, is a research analyst employed by Credit Suisse Securities (Japan) Limited.

For Credit Suisse disclosure information on other companies mentioned in this report, please visit the website at www.credit-suisse.com/researchdisclosures or call +1 (877) 291-2683.

Disclaimers continue on next page.

This report is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or which would subject Credit Suisse, the Swiss bank, or its subsidiaries or its affiliates ("CS") to any registration or licensing requirement within such jurisdiction. All material presented in this report, unless specifically indicated otherwise, is under copyright to CS. None of the material, nor its content, nor any copy of it, may be altered in any way, transmitted to, copied or distributed to any other party, without the prior express written permission of CS. All trademarks, service marks and logos used in this report are trademarks or service marks or registered trademarks or service marks of CS or its affiliates.

The information, tools and material presented in this report are provided to you for information purposes only and are not to be used or considered as an offer or the solicitation of an offer to sell or to buy or subscribe for securities or other financial instruments. CS may not have taken any steps to ensure that the securities referred to in this report are suitable for any particular investor. CS will not treat recipients as its customers by virtue of their receiving the report. The investments or services contained or referred to in this report may not be suitable for you and it is recommended that you consult an independent investment advisor if you are in doubt about such investments or investment services. Nothing in this report constitutes investment, legal, accounting or tax advice or a representation that any investment or strategy is suitable or appropriate to your individual circumstances or otherwise constitutes a personal recommendation to you. CS does not offer advice on the tax consequences of investment and you are advised to contact an independent tax adviser. Please note in particular that the bases and levels of taxation may change.

CS believes the information and opinions in the Disclosure Appendix of this report are accurate and complete. Information and opinions presented in the other sections of the report were obtained or derived from sources CS believes are reliable, but CS makes no representations as to their accuracy or completeness. Additional information is available upon request. CS accepts no liability for loss arising from the use of the material presented in this report, except that this exclusion of liability does not apply to the extent that liability arises under specific statutes or regulations applicable to CS. This report is not to be relied upon in substitution for the exercise of independent judgment. CS may have issued, and may in the future issue, a trading call regarding this security. Trading calls are short term trading opportunities based on market events and catalysts, while stock ratings reflect investment recommendations based on expected total return over a 12-month period as defined in the disclosure section. Because trading calls and stock ratings reflect different assumptions and analytical methods, trading calls may differ directionally from the stock rating. In addition, CS may have issued, and may in the future issue, other reports that are inconsistent with, and reach different conclusions from, the information presented in this report. Those reports reflect the different assumptions, views and analytical methods of the analysts who prepared them and CS is under no obligation to ensure that such other reports are brought to the attention of any recipient of this report. CS is involved in many businesses that relate to companies mentioned in this report. These businesses include specialized trading, risk arbitrage, market making, and other proprietary trading.

Past performance should not be taken as an indication or guarantee of future performance, and no representation or warranty, express or implied, is made regarding future performance. Information, opinions and estimates contained in this report reflect a judgement at its original date of publication by CS and are subject to change without notice. The price, value of and income from any of the securities or financial instruments mentioned in this report can fall as well as rise. The value of securities and financial instruments is subject to exchange rate fluctuation that may have a positive or adverse effect on the price or income of such securities or financial instruments. Investors in securities such as ADR's, the values of which are influenced by currency volatility, effectively assume this risk.

Structured securities are complex instruments, typically involve a high degree of risk and are intended for sale only to sophisticated investors who are capable of understanding and assuming the risks involved. The market value of any structured security may be affected by changes in economic, financial and political factors (including, but not limited to, spot and forward interest and exchange rates), time to maturity, market conditions and volatility, and the credit quality of any issuer or reference issuer. Any investor interested in purchasing a structured product should conduct their own investigation and analysis of the product and consult with their own professional advisers as to the risks involved in making such a purchase.

Some investments discussed in this report have a high level of volatility. High volatility investments may experience sudden and large falls in their value causing losses when that investment is realised. Those losses may equal your original investment. Indeed, in the case of some investments the potential losses may exceed the amount of initial investment, in such circumstances you may be required to pay more money to support those losses. Income yields from investments may fluctuate and, in consequence, initial capital paid to make the investment may be used as part of that income yield. Some investments may not be readily realisable and it may be difficult to sell or realise those investments, similarly it may prove difficult for you to obtain reliable information about the value, or risks, to which such an investment is exposed.

This report may provide the addresses of, or contain hyperlinks to, websites. Except to the extent to which the report refers to website material of CS, CS has not reviewed the linked site and takes no responsibility for the content contained therein. Such address or hyperlink (including addresses or hyperlinks to CS's own website material) is provided solely for your convenience and information and the content of the linked site does not in any way form part of this document. Accessing such website or following such link through this report or CS's website shall be at your own risk.

This report is issued and distributed in Europe (except Switzerland) by Credit Suisse Securities (Europe) Limited, One Cabot Square, London E14 4QJ, England, which is regulated in the United Kingdom by The Financial Services Authority ("FSA"). This report is being distributed in Germany by Credit Suisse Securities (Europe) Limited Niederlassung Frankfurt am Main regulated by the Bundesanstalt fuer Finanzdienstleistungsaufsicht ("BaFin"). This report is being distributed in the United States by Credit Suisse Securities (USA) LLC ; in Switzerland by Credit Suisse; in Canada by Credit Suisse Securities (Canada), Inc.; in Brazil by Banco de Investimentos Credit Suisse (Brasil) S.A.; in Japan by Credit Suisse Securities (Japan) Limited, Financial Instrument Firm, Director-General of Kanto Local Finance Bureau (Kinsho) No. 66, a member of Japan Securities Dealers Association, The Financial Futures Association of Japan; elsewhere in Asia/Pacific by whichever of the following is the appropriately authorised entity in the relevant jurisdiction: Credit Suisse (Hong Kong) Limited, Credit Suisse Equities (Australia) Limited, Credit Suisse Securities (Thailand) Limited, Credit Suisse Securities (Malaysia) Sdn Bhd, Credit Suisse Singapore Branch, Credit Suisse Securities (India) Private Limited, Credit Suisse Securities (Europe) Limited, Seoul Branch, Credit Suisse Taipei Securities Branch, PT Credit Suisse Securities Indonesia, and elsewhere in the world by the relevant authorised affiliate of the above. Research on Taiwanese securities produced by Credit Suisse Taipei Securities Branch has been prepared by a registered Senior Business Person. Research provided to residents of Malaysia is authorised by the Head of Research for Credit Suisse Securities (Malaysia) Sdn. Bhd., to whom they should direct any queries on +603 2723 2020.

In jurisdictions where CS is not already registered or licensed to trade in securities, transactions will only be effected in accordance with applicable securities legislation, which will vary from jurisdiction to jurisdiction and may require that the trade be made in accordance with applicable exemptions from registration or licensing requirements. Non-U.S. customers wishing to effect a transaction should contact a CS entity in their local jurisdiction unless governing law permits otherwise. U.S. customers wishing to effect a transaction should do so only by contacting a representative at Credit Suisse Securities (USA) LLC in the U.S.

Please note that this report was originally prepared and issued by CS for distribution to their market professional and institutional investor customers. Recipients who are not market professional or institutional investor customers of CS should seek the advice of their independent financial advisor prior to taking any investment decision based on this report or for any necessary explanation of its contents. This research may relate to investments or services of a person outside of the UK or to other matters which are not regulated by the FSA or in respect of which the protections of the FSA for private customers and/or the UK compensation scheme may not be available, and further details as to where this may be the case are available upon request in respect of this report.

Any Nielsen Media Research material contained in this report represents Nielsen Media Research's estimates and does not represent facts. NMR has neither reviewed nor approved this report and/or any of the statements made herein.

If this report is being distributed by a financial institution other than Credit Suisse, or its affiliates, that financial institution is solely responsible for distribution. Clients of that institution should contact that institution to effect a transaction in the securities mentioned in this report or require further information. This report does not constitute investment advice by Credit Suisse to the clients of the distributing financial institution, and neither Credit Suisse, its affiliates, and their respective officers, directors and employees accept any liability whatsoever for any direct or consequential loss arising from their use of this report or its content.

Copyright 2009 CREDIT SUISSE and/or its affiliates. All rights reserved.

CREDIT SUISSE SECURITIES (USA) LLC
United States of America: +1 (212) 325-2000