In this Issue

Contributors

Mirae Asset Global Investments (Hong Kong)
Asia Pacific Investment/Research

Wei Wei Chua
Senior Investment Analyst

Autonomous & Electric Vehicles: Smartphones on Wheels

Executive Summary

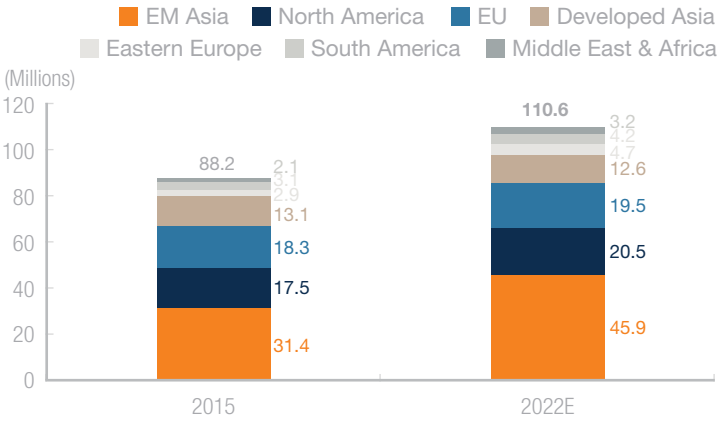
The dawn of electric vehicles and autonomous driving raises questions for the Asian auto sector. At play are the obsolescence of traditional internal combustion engine cars, the winners and losers that will emerge from this paradigm shift and the role of safety and regulatory issues. Here we address such issues, drawing on our primary on-the-ground research to examine the impact of self-driving technology on the industry throughout the value chain, from the supplier to the driver and passenger.

On the Cusp of Revolution

In 2015 over 88 million light vehicles were sold globally, a number forecasted to grow by 25% and exceed 110 million vehicles by 2022. More than 90% of top line volume gains will be driven by emerging markets, such as China and India, on the back of the mega-trends of a growing middle class and rising consumption.

Global Light Vehicle Sales: 2015 vs. 2022E

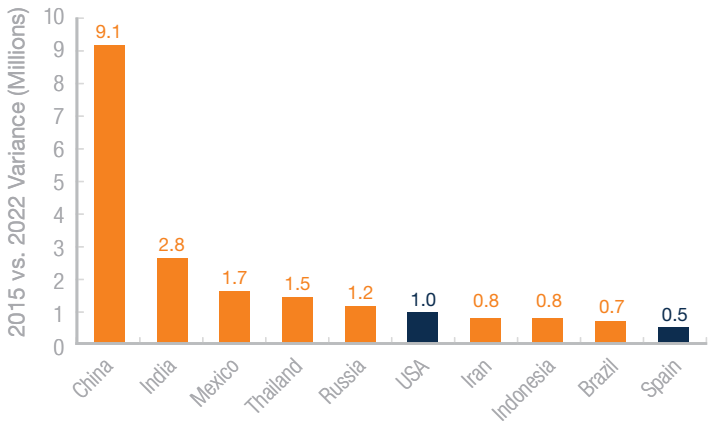
Source: PwC Autofacts (2016 Q1), Mirae Asset Global Investments



Note: Light vehicle is defined as a motor vehicle with at least four wheels and a maximum weight of 3.5 tons

Top 10 Volume Growth Markets: 2015 vs. 2022E

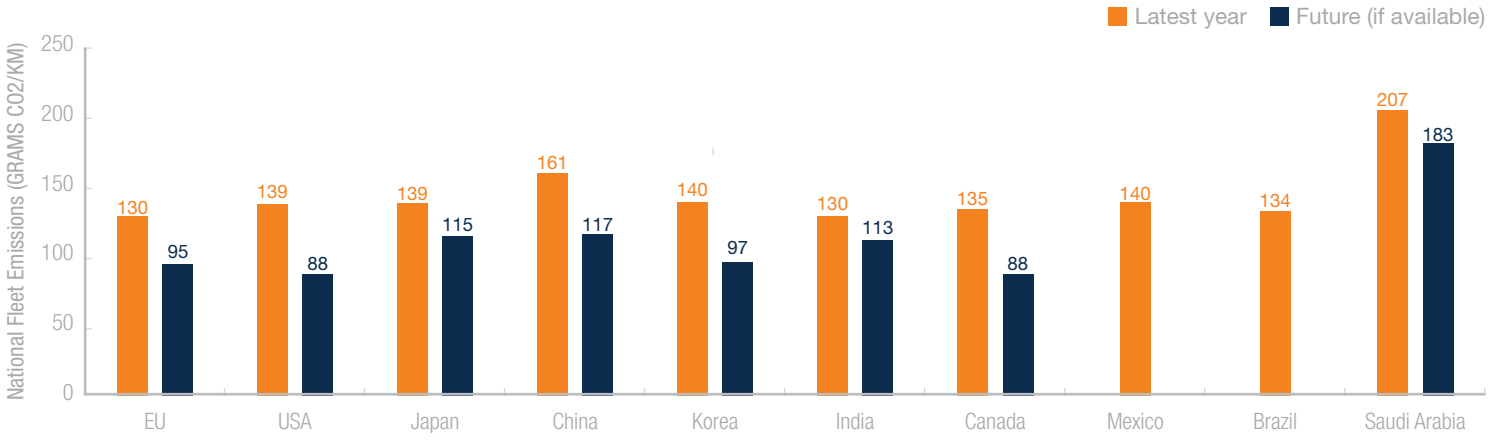
Source: PwC Autofacts (2016 Q1), Mirae Asset Global Investments



The car market is in the early stages of a wholesale revolution owing to several critical factors weighing on internal combustion engine (ICE) vehicles. Cars have a low seat-mile utilization of just 1%, remaining idle the rest of the time. The ever-expanding fleet of ICE cars engenders extraction and burning of finite oil resources, accounting for 45% of global oil demand, or roughly 500 billion gallons of fuel per year as estimated by Morgan Stanley.[1] Toxic emissions and particulate matter pose acute environmental and human health risks, in addition to carbon dioxide. As a result, regulators have addressed growing emissions from transport. In addition to national research and development (R&D) programs for clean tech vehicles, regulatory instruments include revised fuel taxes, consumer subsides for the purchase of fuel efficient vehicles and registration fees or license plate quotas. Regulations in developed and emerging markets are becoming more stringent for passenger vehicles as evidenced in the lowering fleet emissions standards.

Global Vehicle Fleet Emissions by Major Geography

Source: MSCI ESG Research, International Council on Clean Transportation (ICCT), Mirae Asset Global Investments (September 2016)



Note: Respective latest & future years as follows: EU: 2015 / 2021; USA: 2016 / 2025; Japan: 2015 / 2020; China: 2015 / 2020; Korea: 2015 / 2020; India: 2016 / 2021; Canada: 2016 / 2015; Mexico: 2016; Brazil: 2017; Saudi Arabia: 2015 / 2020

[1] Morgan Stanley, "9 Industries That Could Benefit From Autonomous Driving" (October 2016)

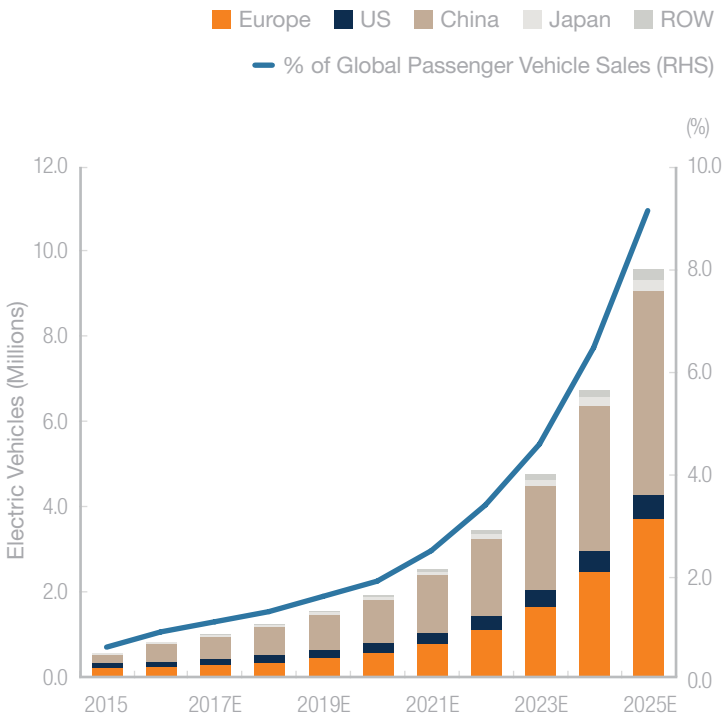
What is even more striking is that current ICEs operate with a low energy conversion efficiency close to 20%, leading to 80% waste in exhaust, cooling, friction and heat. From an environmental and public safety perspective, the large carbon footprint – 6 to 35 tons of CO2 released to manufacture ICEs cars[2] – coupled with the 3,500 global daily traffic fatalities[3], there are glaring detractors against a business-as-usual scenario for ICEs.

More recently, market sentiment has been affected by scandals that embroiled Mitsubishi, and later Volkswagen, concerning the tampering of fuel-efficiency test data and emissions standards. With regulators becoming more rigorous with regards to emissions, it is likely that the adoption of EVs becomes even more prevalent.[4] The technological shortcomings of combustion engine engineering are coming to a head, pushing the automobile sector toward electric vehicles along with varying degrees of automated driving.

> *"The technological shortcomings of combustion engine engineering are coming to a head, pushing the automobile sector toward electric vehicles along with varying degrees of automated driving."*

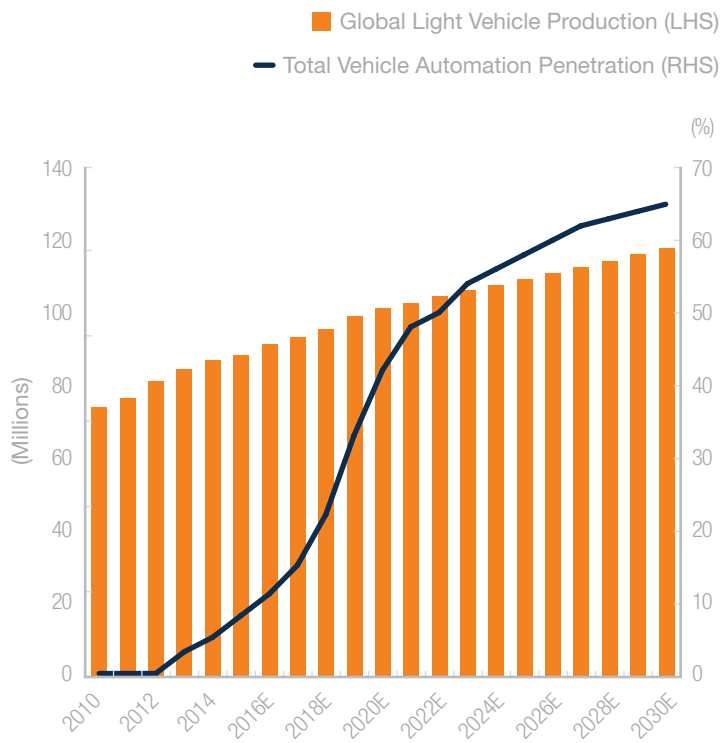
Electric Vehicle Sales by Market

Source: UBS Estimates, Mirae Asset Global Investments (2016)



Global Vehicles and Automation Penetration

Source: J.P. Morgan, Mirae Asset Global Investments (2016)



[2] The Guardian, "What's the carbon footprint of…a new car?" (September 2016)

[3] World Health Organization, World Health Statistics 2016 Report

[4] Daiwa Capital Markets, "Korea Automobiles and Components Sector: Electric Vehicles and Smart Cars: Reinventing the Wheel" (2016)

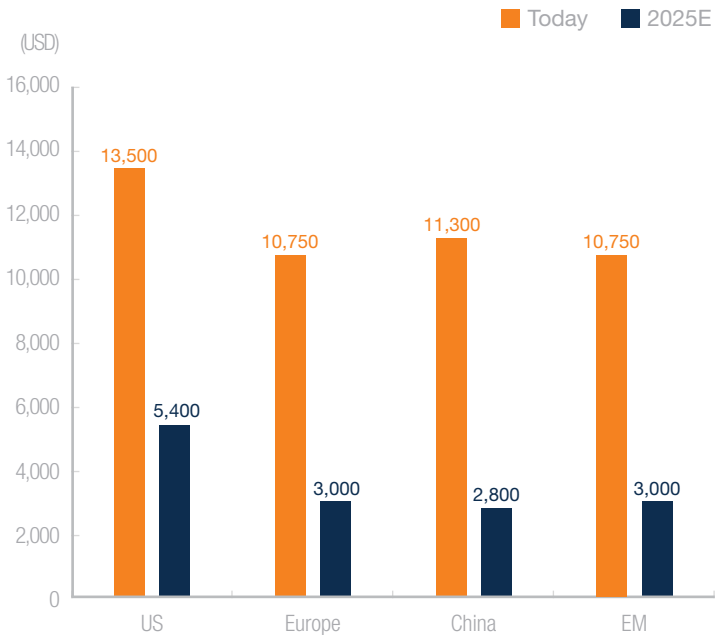
Moving Parts

The transition to electric and autonomous modes of transport rests on several unfolding developments. An overriding issue for EVs is the driving range afforded from one battery charge. Efficient thermal management is critical to converting battery power into distance, which is key for mass adoption of EVs. The minimum distance threshold is around 350km for scale usage, with major players offering driving ranges of 350-500km in existing models. Another activation bottleneck related to battery charge is the location and availability of charging stations. Electric vehicle charging infrastructure is increasingly prioritized in national interests, typified by the US Department of Transportation (DOT) in November 2016 announcing a plan for federal electric vehicle corridors as a bid to advance zero emission vehicles.[5]

Pricing is the final piece of the puzzle for mass EV adoption. Recent lower oil prices could have tempered the faster take-up of EV adoption from traditional ICE vehicles when customers conduct a cost-benefit analysis. EV models are around one-third more expensive than comparable ICE options. However, as lithium-ion battery technology becomes more advanced, the cost of EVs will inevitably come down. The average battery cost will be roughly USD 150 per kilowatt hour in 2020, down from USD 1,000 per kilowatt hour in 2010.[6] These trends will bring EVs significantly closer to cost parity against ICEs within the next ten years.

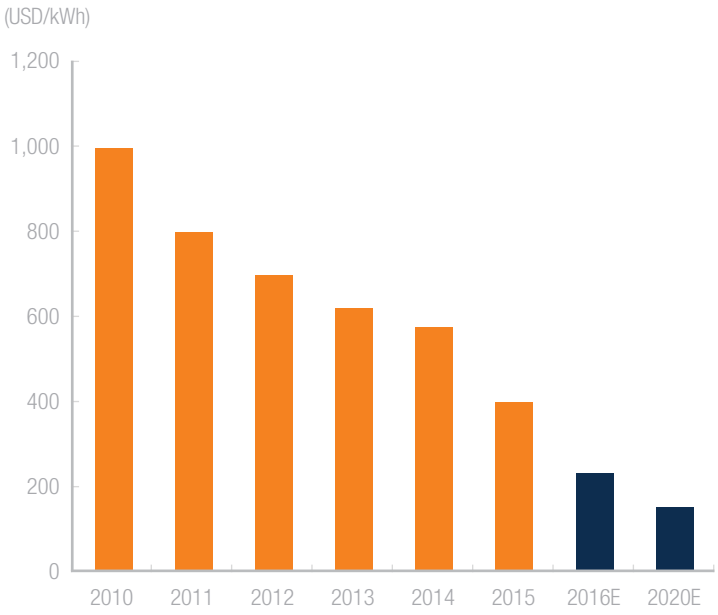
Price Differential Battery Electric Vehicle vs. Internal Combustion Engines

Source: UBS, Mirae Asset Global Investments (2016)



Lithium Ion Battery Downward Cost Curve

Source: Daiwa Forecasts (2016)



[5] NPR, Administration Gives Electric Charging Grid A Boost (November 2016)
[6] Daiwa Forecasts (2016)

Winners vs. Losers

The shift towards EVs is inevitable, and will negatively affect equipment manufacturers (OEMs) whereas parts suppliers stand to gain from the transition. OEMs are currently facing disruption from more nimble technology companies, such as Tesla and Google, whereas proprietary powertrain technology is being replaced by more commoditized battery solutions. The latest move by Samsung to acquire the high-end US-based auto parts supplier Harman International Industries for USD 8 billion (the largest ever acquisition for Samsung Group) highlights the jockeying for position by non-traditional players in the automobile space.[7]

Manufacturing EVs is mostly margin dilutive for OEMs at this stage given the small volumes, but failing to jump on to the EV bandwagon could render OEMs obsolete. We have observed cases of EV makers taking 15 to 20 years to bring operating margins in line with core business units owing to lower volumes. Nonetheless, OEMs are limited in how they can respond to the EV shift and will likely opt to take the leap, whether on their own terms or through joint ventures.

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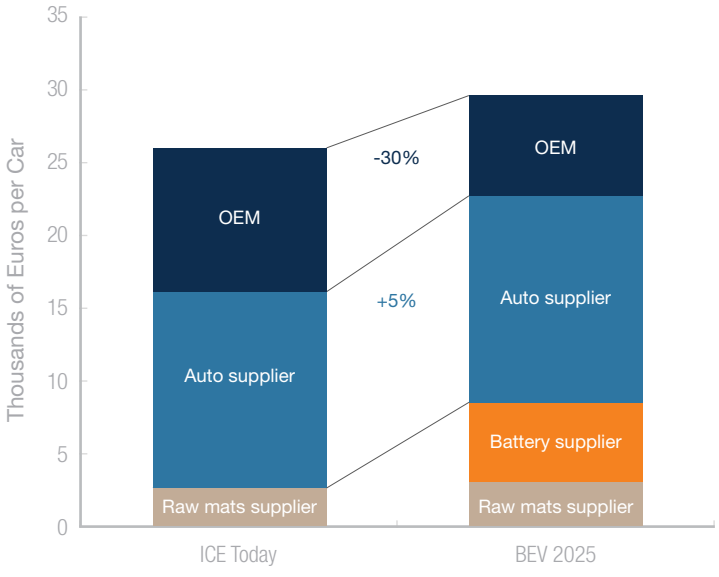
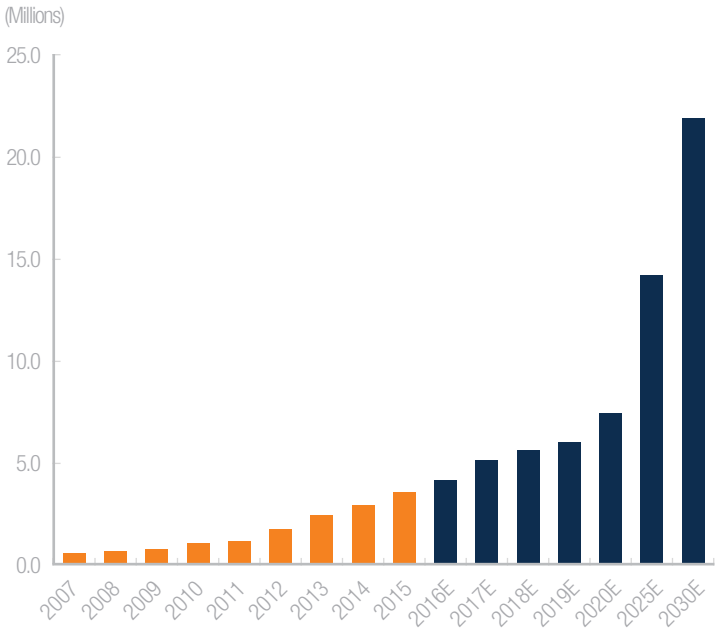
Value Creation of Existing ICE vs. Battery EV in 2025E

Source: UBS, Mirae Asset Global Investments (September 2016)



Advanced-Automotive Battery Unit Forecast

Source: Bloomberg, Mirae Asset Global Investments (2016)



[7] Financial Times, "Samsung to pay $8bn for US car tech group Harman" (November 2016)

Smartphone on Wheels

As the automotive industry moves to autonomous driving, cars will increasingly become "smartphones on wheels," opening up the sector to a myriad of new dynamics and business models. The roadmap toward driverless cars is divided into several layers as defined by the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA), ranging from no automation and partial advanced driver assistance (ADAS) all the way to full automation. Autonomous cars represent a sophisticated blend of computing power and artificial intelligence to navigate real-world driving scenarios in real-time.

ADAS systems are at the fore of this transformation. The automobile sector is fast becoming like the smartphone industry, where new entrants can compete as long as they have enough financial backing to achieve scale and incrementally drive down costs. In a similar fashion to what Foxconn did for Apple and Huawei, we see an analogous situation unfolding where suppliers benefit from an open architecture sourcing model employed by startup EV companies and incumbent OEMs. The barriers to entry for producing passenger vehicles are significantly reduced with Asian players poised to reap the benefits from this trend, and we have identified several companies of interest in Northeast Asia during our research trips.

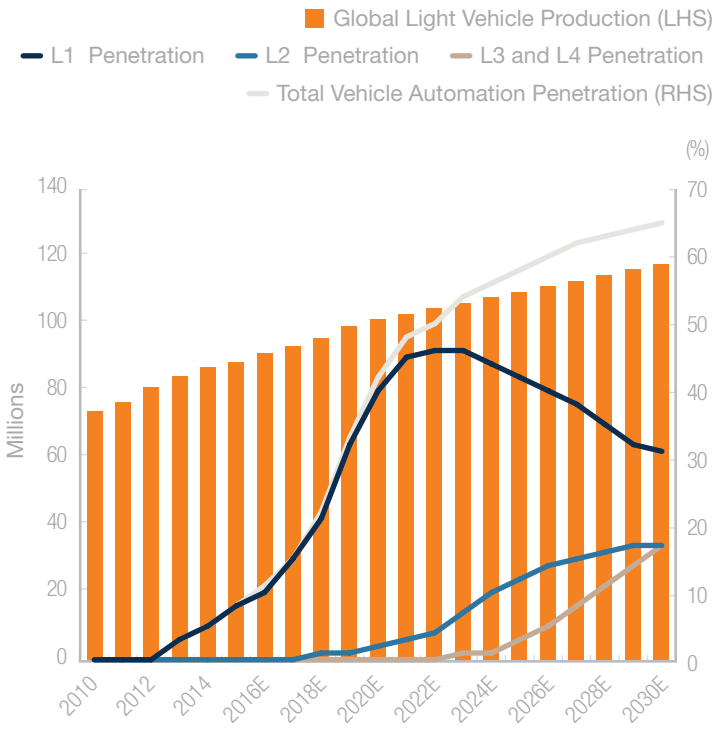
Four Levels of Vehicle Automation

Source: NHTSA, J.P. Morgan, Mirae Asset Global Investments (2016)

Level	Description	Capabilities	Benefits	Requirements
Level 0	No Automation	No driver assistance	Baseline	Baseline
Level 1	Use of ADAS	Assistance to avoid collisions / enhance convenience	Fewer accidents	Blind Spot Detection / Forward Collision Warning / Automatic Emergency Braking / Rear Collision Warning / Lane Departure Warning
Level 2	Semi-Autonomous	Driver disengagement of driving functions in certain scenarios	Modestly fewer accidents and more convenient	Parking Assist / Adaptive Cruise Control Traffic Jam Assist
Level 3	Limited Self-Driving	Driver is free to disengage in certain driving conditions, but required to remain available take over control with notice	Much fewer accidents and more convenient	Highway Automated Driving / City road driving / Country road driving
Level 4	Full Automation	No driver required No exceptions in terms of conditions	Significantly fewer accidents; Improved traffic flow; Fully convenient	Requires advanced Level 3 /capabilities with real-time updates to maps, V2X communciation, and regulatory changes

Global Vehicles and Automation Penetration

Source: J.P. Morgan, Mirae Asset Global Investments (2016)



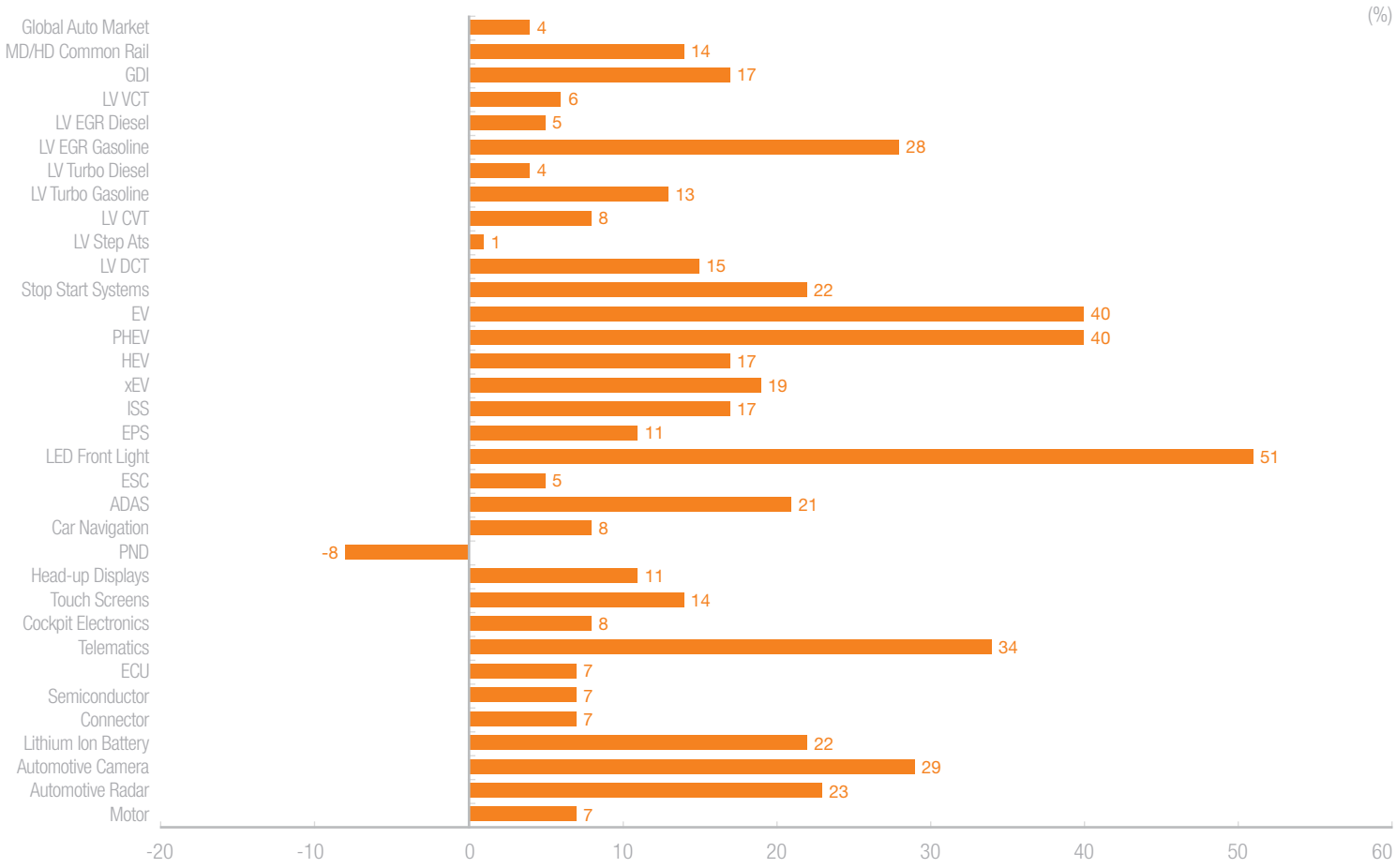
Parts Makers in Taiwan and Korea

While talking to auto-parts makers in Taiwan we have learned of the existence of many smaller electric vehicle start-up companies such as Faraday Future (big Chinese financing) and Atieva. During our visit to Mando's anti-lock brake system factory and Hanon System's compressor production line in the outskirts of Seoul, Korea it was evident that these parts suppliers have extended their scope beyond merely supplying to Korean automobile companies such as Hyundai and Kia. Instead, they have diversified exposure to the likes of global OEMs including BMW, Ford, and GM.

Tesla's ability to source key components from Taiwan suggests that volume is the key bottleneck for industry disruption. We believe it affects the long-term moat of traditional OEMs, which used to have proprietary drivetrain/powertrain technology and the value chain to supply and assemble unique product parts. However, the electric motor requires fewer moving parts – namely a charger, battery, controller, and motor.[8] This is the sustainable competitive advantage of battery technology, and barriers to entry have now come down as a result.

Market Growth of Major Applications and Products Estimated CAGR from 2013-20

Source: Citi Research, Mirae Asset Global Investments (2016)



[8] Idaho National Laboratory, How Do Gasoline & Electric Vehicles Compare?

Regulation and Safety

The major automobile players are committed to have a commercially viable fully self-driving car by about 2020. Semi-autonomous driving technology is already available or close to being perfected. However, we believe that regulation will lag behind technological innovation. For Tesla, the accident that occurred earlier this year will be a headwind for wider rollouts by inducing more stringent red-tape.[9] The question being asked is who, ultimately, is the bearer of responsibility in the event of an autonomous vehicle accident? Is it the passenger (driver) or the OEM? Based on our discussions with industry experts, it seems that OEMs should shoulder the responsibility if the car was driving autonomously. While liability poses a difficult problem for regulation and the debate around safety will continue for some time to come, we remain optimistic that the driverless world is more a question of "when" rather than "if."

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Global Safety Regulation Events

Source: iResearch, Mirae Asset Global Investments (2016)

Year	Region	Outline
2013	North America	US NCAP adds points for LDW and FCW
2013	Europe	LDP and AEB made compulsory for large vehicles
2014	Europe	ECS made compulsory for all new vehicles
2014	Europe	Euro NCAP adds points for LDW and AEB
2014	Japan, Korea, Europe	ECS made compulsory for all new vehicles
2014	Japan	LDP and AEB made compulsory for large vehicles
2014	Japan	Regulations accelerate installation for LDW and AEB in commercial vehicles
2015	North America	Camera installation could be made compulsory under the Kids Transportation Act
2015	Europe	Europe modifies side camera ISO regulations
2016	Europe	Euro NCAP adds points for PD (Pedestrian Detection) and AEB
2016	Japan	Japan could approve side mirrors
2017	North America	North America approves side mirror cameras
2017	North America	US NCAP adds points for PD and AEB
2018	Japan	Japan could approve the use of autonomous parking assist
2018	Europe	Europe NCAP adds points for night-use PD and AEB
2018	EM Countries	EM Country NCAP considers adding points for PD and AEB

[9] Tesla Company Disclosure

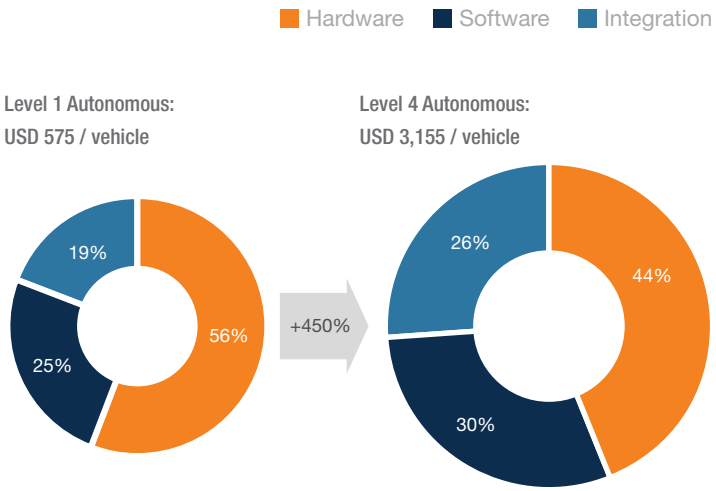
The safety content for vehicles will increase dramatically in an attempt to reduce accidents. Regulation will serve as a support mechanism in this regard. For example, the US government will mandate that all vehicles less than 10,000 pounds built from May 2018 onwards be equipped with rear-view (back-up) cameras. This corroborates our findings from different OEMs and auto parts companies.

The number of sensors and cameras per vehicle will increase from up to four today to a 10 or 12 sensor surround view. Some luxury vehicles already have surround view today. While safety measures may not be as common in emerging market countries as they are in developed markets, the gap will eventually close. Safety features that are currently optional – such as parking sensors or assisted parking – will become mandatory just as seat belts were made compulsory starting from the 1970s.

The uptick in safety content will result in increased content per vehicle, altogether flowing through to significant production targets for parts manufacturers. While cost per part may trend downward with competition and typical annual price cuts from OEMs to their suppliers, we argue that volumes and higher efficiency will more than compensate to lift revenues and margins for robust earnings growth in the medium to long-term for parts companies aligned to this theme.

Content Per Vehicle Opportunity

Source: Strategy Engineers, JP Morgan (July 2016)



Hitching a Ride to Invest

As an investor, we look to buy companies that supply to different OEMs, which is more of a diversified and hedged play than betting on a single OEM. We are bullish on Asian parts suppliers who are fast catching up with their European peers in terms of efficiency and quality. These Asian players are recognized for their ability to churn out rush orders, especially those originating from Korea and Taiwan. Such suppliers are able to deliver on time for clients like Tesla, whereas Continental Europe suppliers are more likely to encounter overwork regulations. Furthermore, we find that quality is becoming less of a differentiator between Asian and continental competitors, while price points in Asia are considerably lower due to cheaper labor inputs. In short, timeliness and cost-effectiveness are notable advantages for Asian players, and those that execute with excellence will inevitably gain a larger slice of the growing EV/autonomous vehicle pie.

At Mirae Asset Global Investments, we strive to identify Asian sector leaders who lead this tectonic shift with strong sustainable competitiveness. We believe the EV/autonomous disruption of the automotive space provides significant opportunities for bottom-up stock pickers to deliver long term alpha.

> *“EV/autonomous disruption of the automotive space provides significant opportunities for bottom-up stock pickers to deliver long term alpha”*

Global Offices

Mirae Asset Global Investments
East Tower 26F, Mirae Asset CENTER1 Bldg,
67, Suha-dong, Jung-gu,
Seoul, Korea (100-210)
Tel.+82-2-3774-8200

Mirae Asset Global Investments (HK)
Level 15, Three Pacific Place, 1 Queen's
Road East, Hong Kong, HK
Tel.+852-2295-1500

Mirae Asset Global Investments (UK)
4-6 Royal Exchange Buildings,
London, EC3V 3NL, United Kingdom
Tel. +44-20-7715-9900

Mirae Asset Global Investments (USA)
1350 Avenue of the Americas,
33rd Floor, New York, NY, 10019, USA
Tel. +1-212-205-8300

Mirae Asset Global Investments (Taiwan)
6F, NO. 42, Sec.2 Zhongshan N. Rd.,
Taipei City 10445, Taiwan (R.O.C)
Tel. +886-2-7725-7555

Mirae Asset Global Investments (India)
Unit No. 606, 6th Floor, Windsor Building
Off. C.S.T Road, Vidyanagari Marg.
Kalina, Sanatacruz (East), Mumbai
400 098, India
Tel. +91-22-6780-0300

Mirae Asset Global Investments (Brazil)
Rua Olimpíadas, 194/200,
12 Andar, CJ 121, Vila Olímpia
São Paulo, CEP 04551-000, Brazil
Tel: +55-11-2608-8500

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