E-mobility index for Q3 2013

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Key takeaways of the e-mobility index for Q3 2013

1. Vehicle technology is at series production level in nearly all countries except China, where there is room for improvement. Governments are increasingly moving away from subsidizing only technology research, given the growing technological maturity. Instead, they aim to directly stimulate sales volumes and anchor value added locally.

2. Compared to the last e-mobility index, production forecasts for e-vehicles are still down overall, despite slowly rising sales volumes; only the US is bucking the trend.

3. Vehicle prices are falling sharply overall. But the cost regression cannot yet be explained by economies of scale. OEMs’ focus is more on strategic market positioning within different EV/PHEV business models.

Summary comparison of the competitive positions of the world’s seven leading automotive nations

In terms of technology, Germany has taken over the lead from South Korea. German OEMs have further improved their technological offering and have also reduced vehicle prices further. In Japan, too, manufacturers have reduced selling prices significantly in some cases and thus made up at least partly for lower customer demand now that subsidies have run out. The trend toward falling prices with comparatively high-level technology can also be seen in the US, but there the more expensive vehicles dominate the market (especially the Tesla Model S). In China, the technological level will improve in the medium term, since the local brands of Chinese-international joint ventures will bring more EV models onto the market (Figure 3).

Compared to the last survey, government R&D subsidies have changed only in relation to economic output; in absolute terms, the subsidy volume has remained constant (Figure 4). As the level of technology achieved is now high – albeit with room for more innovation in e.g. batteries, drive systems or lightweight construction – most markets will probably see the phase-out of state subsidies for enhancing vehicle engineering. Instead, the normal competitive mechanisms are increasingly coming into play, changing the subsidy landscape beyond recognition. This will force governments, in particular, to realign their subsidy strategies in the medium term.

Instead of focusing just on technological, and in some cases pre-competitive, research subsidies, both public- and private-sector players are now concentrating on setting up a comprehensive recharging infrastructure, especially for fast charging (see the index for Q1 2013). In addition to more extensive subsidies for volumes through monetary and non-monetary factors (e.g. certain privileges for xEV owners in metropolitan areas), promoting further industrialization of e-mobility via targeted investment in new manufacturing technologies and processes will be crucial to keeping manufacturing local and creating new jobs.
In industry, Japan was the only country to improve its index ranking, greatly extending its diminishing lead since the last survey (see the index for Q1 2013). The reason is primarily a rise in Japan’s global market share of cell production due to the higher sales forecasts for the Tesla Model S. But this rise is mainly reflected in higher demand for consumer cells (type 18650A) not originally designed for use in cars (used only by Tesla instead of the more common pouch cells). Japan, and Panasonic-Sanyo in particular, thus benefit more than most from higher demand in the US. In cell manufacturing, the relative market positions of leading automakers are changing significantly. Despite increases in the vehicle production forecast, the US is losing its share of cell value added at the same pace. In all other markets, the declining volume forecasts lead directly to fewer cells being manufactured (Figure 6).

In terms of vehicle sales volumes, prospects improved only in the US in the period reviewed. In all other countries, prospects are getting worse. Shifts in global production shares between countries are minor compared to the index for Q1 2013, as the global xEV product mix is increasingly stabilizing. Vehicle lines designed specially for EV or PHEV dominate. Only in exceptional cases do electric versions of existing series make it to the top, and only in China will there be some major shifts in the model mix in the medium term (Figure 5).

In terms of market, the absolute sales figures, except in Japan, have continued to be positive since the last index for Q1 2013. With a shrinking overall market, the market shares of electric and plug-in vehicles are increasing. The US is becoming the leading market for e-mobility, with stable monthly volumes in the thousands. Here we can see the impact of comprehensive programs offering monetary and non-monetary purchase incentives. The German market, along with Korea, Italy and China, has the lowest shares of EV and PHEV sales and is declining significantly compared to the four leading markets by volume. Upcoming market launches of electric vehicles by national OEMs in the volume segment (e.g., BMW i3, Volkswagen e-up!) may boost the market through higher volumes, as the models on offer from international manufacturers have not been especially popular so far (Figure 7).
Detailed analysis

1. OEMs’ business models vary greatly; customer preferences still vague

In the current early phase of launching EV series production, the OEMs have few robust planning figures in terms of customer profiles and user requirements in the various markets. OEMs are responding to this with different types of technological positioning and business models, though no clear model for success is yet apparent.

Thus German OEMs are positioning themselves more and more as providers of integrated mobility services. The aim is to spread the higher technology unit costs of electric drive systems (see index for Q1 2013) across a larger number of individual users or cross-subsidize them by offering extra services. By contrast, French OEMs' business models focus mainly on further reducing the purchase price for the end user. They are pursuing this goal by offering lower-tech cars and splitting off the main cost driver, batteries, from the selling price. The add-on services offered by French OEMs are thus limited to renting out the battery and arranging contracts to supply electricity.

Among Japanese manufacturers, electric cars are mainly niche products aimed at certain user profiles and regions, without a dedicated business model. Instead, Japanese OEMs aim to further consolidate their lead in electric drive technology, gained through hybrid cars, by quickly spreading a self-defined fast-charging standard (CHAdeMO) and cross-company collaborations to extend the required charging infrastructure. Close interconnection with suppliers throughout the supply chain according to the keiretsu principle gives this strategy a further boost.

In the US, the EV industry structure is being created by small but very dynamic start-ups with high public profiles, which are even seizing market share from the “Detroit Three” and overseas manufacturers. The business models and model policies of these providers focus mainly on higher-end car segments not filled by traditional OEMs and include free provision of comprehensive fast-charging infrastructure. However, in the first half of 2013 Tesla's Model S poached customers from BMW, Mercedes, Lexus/Toyota and Audi in California and in over half of all purchases replaced conventional-engine premium-segment vehicles (Figure 8).

In China, so far the majority of electric vehicles have been sold in 25 pilot cities, six of which although subsidize the use of EVs as private cars. In addition to a central government subsidy of RMB 3,000 per kWh, the provinces (and some OEMs) subsidize the purchase of EVs as well. Besides direct subsidies for the purchase price, municipalities now also focus on renting out EVs. In infrastructure provision, the two state power companies dominate the market with at times contradictory business models.
2. China – Launching local electric vehicle brands taps customer potential

Electric vehicle manufacturers have high hopes for the Chinese market. In the medium term, the market is set to see a huge number of potential buyers and a very dynamic political framework. This dynamism can be seen, for example, in the ban on two-wheelers with two-stroke engines in large cities, which paved the way for over 40 million electric two-wheelers being sold per year. So China continues to be strategically relevant to local and international OEMs in the field of e-mobility.

However, we can see major successes in the spread of electric vehicles only in a few provinces in China with heavy local (sales) incentives (Figure 9). As has already happened in Beijing, Shanghai and Hangzhou, some cities are also planning to integrate electric vehicles into car-sharing fleets. An overall industry standard for slow charging has mostly been implemented but fast charging is taking longer to standardize in China. At the same time, there are doubts about the safety of electric drive systems. As a result, engineers in China are now moving away from purely battery-powered electric cars toward hybrids and plug-in hybrids.

New impetus for the introduction of electric vehicles in China is expected in the coming years, especially through the launch of new local EV brands from Chinese-international joint ventures. These dominate the Chinese car market at the moment, with around 80% market share, and leverage their good market position among conventional models to market the new technology. The aim of the launch is to meet two standards set by the Chinese authorities. First, the joint launch of a local brand under the direction of the Chinese partner; second, developing and locally manufacturing electric vehicles by using one or more key components (battery, power electronics, electric motor) developed in China and patented by a Chinese firm.

To avoid cannibalizing international OEMs’ existing brands, most local brands are positioned in a lower-priced segment than the usual range, a segment served only by local manufacturers. For foreign OEMs, this presents the challenge of developing separate, cost-optimized drivetrain systems for China and thus positioning themselves in the market so that these do not compete with their own systems, either technologically or commercially. At the same time, local manufacturers are increasingly coming under pressure to compete with foreign OEMs in their original vehicle and price segments.
3. Low-voltage drivetrain technologies – Solution for emerging markets?

In China and other emerging markets, international OEMs in particular must find inexpensive engineering solutions tailored to specific user groups. In this context, metropolitan areas play more of a role than in other markets in shaping customer profiles for electric vehicles. Due to customers’ high cost sensitivity, more pragmatic use of cars and their specific requirements and driving profiles, small cars with limited power and range play a special role for these urban customers.

Statutory regulations for launching battery-powered electric cars in emerging markets tend to be much less developed, or completely absent, in contrast to Europe (ECE-R 100), the US (FMVSS No. 305) and Japan (TRIAS 67-2, TRIAS 67-3). In aftersales, emerging markets have virtually no structures in place for properly handling high voltages. And finally, some customers have major reservations about the safety of electric drive systems. In this context, a low-voltage drive system for battery-powered electric cars is an appealing technology option for complying with regulations and giving customers the power they want, while at the same time simplifying the production process.

Local manufacturers often go for low-cost solutions for drives with simple electric machines partly taken from other applications such as manufacturing technology and adapted for use in cars. By contrast, international manufacturers and suppliers can draw on extensive expertise in low-voltage technologies (such as a 48-volt electrical system with a starter generator). In these systems, electric motors with output of up to 12 kW are now used for hybrids, giving enough power to full propel ultra-small vehicles. For example, the European L7e licensing category caps power at 15 kW; similar vehicle categories are likely to be introduced in other markets. Sufficient driving power for city driving and high vehicle efficiency can be achieved with a low voltage drive system in these weight and size categories.

Functional value can thus be added: For example, in ultra-small vehicles, by distributing the drive power between two or four smallish e-machines close to the wheels you can achieve a purely electric torque vectoring to increase driving stability and dynamics. Besides demonstrating new functions and eliminating the disadvantages of high voltage levels, from the manufacturer’s and supplier’s viewpoint, a low-voltage drive system can also create cost advantages through economies of scale in the hybrid product portfolio. This allows international OEMs to reinforce their competitive position long term in the core segment of OEMs from emerging markets.
Methodology

The relative competitive position of individual automotive nations is compared to that of the others on the basis of three key indicators:

1. **Technology:** The current status of technological development in vehicles made by indigenous OEMs and the support for vehicle development provided by national subsidy programs

2. **Industry:** The regional value added created in the automotive industry by national vehicle, system and component production

3. **Market:** The size of the national market for electric vehicles based on current customer demand

Roland Berger Strategy Consultants and fka weight the individual indicators and combine them to form the E-mobility Index (Figure 10).

The E-mobility Index makes it possible to compare the competitive positions of the world’s seven leading automotive nations (Germany, France, Italy, the US, Japan, China and South Korea), juxtaposing their individual automotive markets on the basis of uniform global standards. The index thus reveals the extent to which individual nations are able to participate in the market that e-mobility is creating. The criteria applied are assessed as follows:

1. **Technology:**
   - Technological performance and value for money of electric vehicles that are currently available on the market or are soon to be launched
   - National e-mobility R&D programs through 2015. Only research grants and subsidies are taken into account (but not credit programs for manufacturing, budgets for purchase incentives, etc.)

2. **Industry:**
   - Cumulative national vehicle production (passenger cars, light commercial vehicles) for the period 2012-2015, taking account of BEVs and PHEVs
   - Cumulative national battery cell production (kWh) through 2015

3. **Market:**
   - Electric vehicles’ current share of the overall vehicle market (over a twelve-month period)
Figures

Fig. 1: Competitive positions have remained largely unchanged since the last index

E-mobility index – Q3 2013

Note: Circle size shows EV/PHEV share of total vehicle market
Source: fka; Roland Berger

Fig. 2: Japan is still the clear leader in industry, while Germany is top in technology

E-mobility index – Ranking by indicator

Source: fka; Roland Berger
Fig. 3: Germany is getting even better in technology; Japanese manufacturers are reducing the prices of EVs

Value for money among market-ready BEVs and PHEVs

![Diagram showing the value for money among market-ready BEVs and PHEVs with reference to sales, price, and technology level.

COUNTRY  | Value for Money |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>High-end vehicles dominate the market despite price cuts and new models</td>
</tr>
<tr>
<td>China</td>
<td>Further improvement in technology level at attractive prices</td>
</tr>
<tr>
<td>Germany</td>
<td>Technology level still low; slight rise in prices</td>
</tr>
<tr>
<td>Japan</td>
<td>As before, market tapped via inexpensive vehicles</td>
</tr>
<tr>
<td>USA</td>
<td>Announced vehicles still not launched</td>
</tr>
</tbody>
</table>

Note: Italian OEMs have no market-ready, mass-produced EV/PHEV models
Source: fka; Roland Berger

Fig. 4: Government R&D funding is unchanged since the start of the year and thus still unconnected to economic growth

National R&D funding for e-mobility [EUR m] [% of GDP]

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>[EUR m]1)</th>
<th>[% of GDP]2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>7,684</td>
<td>0.122</td>
</tr>
<tr>
<td>China</td>
<td>2,120</td>
<td>0.017</td>
</tr>
<tr>
<td>Germany</td>
<td>1,984</td>
<td>0.076</td>
</tr>
<tr>
<td>France</td>
<td>925</td>
<td>0.046</td>
</tr>
<tr>
<td>Japan</td>
<td>220</td>
<td>0.025</td>
</tr>
<tr>
<td>USA</td>
<td>180</td>
<td>0.012</td>
</tr>
<tr>
<td>Japan</td>
<td>143</td>
<td>0.003</td>
</tr>
</tbody>
</table>

1) Not including subsidy programs that expired at the end of 2012
2) Subsidies expressed as a share of current GDP
Source: fka; Roland Berger
Fig. 5: Capacity is being increased in the US, while production forecasts are down in all other markets

Projected production of EVs and PHEVs through 2015

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>DOMESTIC PRODUCTION EVS/PHEVS [’000 units]</th>
<th>TOP 3 MODELS IN EACH COUNTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tesla Model S, Chevrolet Volt PHEV, Nissan Leaf EV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toyota Prius PHEV, Nissan Leaf EV, Mitsubishi i-MiEV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Renault Twizy EV, Renault ZOE Z.E., Smart ForTwo EV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMW i3, VW Golf PHEV, VW e-up!</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chery QQEV, Chang’ an E30, Chang’ an Benben Mini EV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hyundai BlueWill PHEV, Kia Ray EV, Chevrolet Spark EV</td>
</tr>
</tbody>
</table>

Note: No significant EV/PHEV production is expected in Italy

Source: fka; Roland Berger

Fig. 6: Japan, and Panasonic-Sanyo in particular, benefit more than most from higher xEV demand in the US

Cell manufacturers and production, by country, through 2015

PROJECTED GLOBAL MARKET SHARE, 20151) | DOMESTIC CELL PRODUCTION, 2012-2015 [MWh]

<table>
<thead>
<tr>
<th>Cell manufacturers and production</th>
<th>[MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panasonic2)</td>
<td>13,773</td>
</tr>
<tr>
<td>SANYO</td>
<td></td>
</tr>
<tr>
<td>Samsung</td>
<td>3,894</td>
</tr>
<tr>
<td>LG Chem</td>
<td>1,908</td>
</tr>
<tr>
<td>TOSHIBA</td>
<td>990</td>
</tr>
<tr>
<td>A123</td>
<td>121</td>
</tr>
<tr>
<td>ANA</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
</tr>
</tbody>
</table>

1) 2015 market value in USD calculated as follows: USD 730/kWh for hybrids, USD 560/kWh for PHEVs and USD 400/kWh for EVs
2) Including Primearth’s market share

Source: : Roland Berger LiB market model as of Q4 2013
**Fig. 7: EV/PHEV sales volumes are rising fast, particularly in the US and France, while Germany lags some way behind**

Sales figures and market share of EVs/PHEVs, Q3 2012 to Q2 2013

<table>
<thead>
<tr>
<th>LAND</th>
<th>SALES EV/PHEV [units]</th>
<th>EV/PHEV SHARE OF TOTAL SALES [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>77,000</td>
<td>0.51</td>
</tr>
<tr>
<td>Japan</td>
<td>15,000</td>
<td>0.31</td>
</tr>
<tr>
<td>China</td>
<td>9,000</td>
<td>0.04</td>
</tr>
<tr>
<td>France</td>
<td>8,900</td>
<td>0.50</td>
</tr>
<tr>
<td>Korea</td>
<td>5,200</td>
<td>0.18</td>
</tr>
<tr>
<td>Germany</td>
<td>700</td>
<td>0.06</td>
</tr>
<tr>
<td>Italy</td>
<td>600</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Source: fka; Roland Berger

**Fig. 8: OEMs are cutting prices for end customers through different types of technological positioning and business models**

Business model comparison

- **Luxury vehicles and free provision of comprehensive fast-charging infrastructure**
- **Focus on car-sharing to expand user pool or cross-subsidization via integrated mobility services**
- **Vehicle provision**
- **Stronger focus on car sharing in the future**
- **Focus on lower-tech vehicles or removing battery from sale price**

Source: fka; Roland Berger
Fig. 9: In China, only a few provinces show major successes in the spread of EVs

Overview of EV sales promotion models in selected key regions

Source: MOST, MOF; Roland Berger

Fig. 10: The e-mobility index compares automotive nations on the basis of three parameters

E-mobility index – Three parameters: Technology, industry, market

Source: fka; Roland Berger
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