In-depth case study: Electric Vehicles (EVs)
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Introduction

New-Energy Vehicles (NEVs) are one of the strategic emerging industries listed in China’s five-year plan for 2016-2020. The term NEV is normally used to designate plug-in electric vehicles eligible for public subsidies, and includes battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel-cell electric vehicles (FCEVs). It is, however, clear that the main focus is on battery electric vehicles, particularly on the passenger car side.

China decided to support the development of Electric Vehicles (EVs) in 2009, but little progress was made until late 2013, when the government announced that it would subsidize carmakers for the electric vehicles they sold\(^1\). In 2015, China became the world’s largest market for electric cars, ahead of the U.S., which was the largest market until that time. Sales of new electric passenger cars on the Chinese market totalled 207,382 units in 2015, made up of 146,719 all-electrics and 60,663 plug-in hybrids\(^2\).

Figure 1. China and U.S. EV sales

![China-US EV sales chart](chart_url)

*(Numbers include passenger cars and commercial cars)*

*Source: EV Volumes, Electric Vehicle Sales Data, 2017*

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\(^1\) National Development and Reform Commission, 2016

\(^2\) China Association of Automobile Manufactures, 2016-01-12
**The current market for New-Energy Vehicles (NEVs)**

**Vehicle sales**

Sales in China of BEVs and PHEVs grew 72% year-on-year in 2017 to 579,000, according to Business Insider Australia. At the same time, sales outside China were 540,000, which means that more than half of the world’s new BEV and PHEV passenger cars were sold in China. With the global market growth at 34%, Chinese growth was substantially stronger than the world average. Business Insider Australia also reports that the increase in market share of EVs was larger in China - 2.3%, up from 1.4% - compared to the rest of the world, where it was 1.4%, up from 1.1%.

**Figure 2. EV and PHEV share of national market**

![Graph showing EV and PHEV share of national market](image)

**Source:** Macquarie Research, January 2018


The Chinese BEV and PHEV market is dominated by national producers, with BYD Auto topping the list of plug-in passenger car sales with 109,485 vehicles sold, before BJEV, which
jumped to second place from fifth in 2016. BJEV also had the bestselling individual model, the EC, followed by Tesla’s Model S⁴.

**Figure 3. Top passenger EV companies by brand sales, 2017**

![2017 passenger EV top sellers by brand](image)

**Table 1. Top passenger EV sales in China by model, 2017**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Model</th>
<th>Sales 2017</th>
<th>Market share %</th>
<th>Rank 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BJEV EC</td>
<td>78079</td>
<td>6</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Tesla Model S</td>
<td>54715</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Toyota Prime</td>
<td>50830</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>4</td>
<td>Nissan Leaf</td>
<td>47195</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Tesla Model X</td>
<td>46535</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>ZD D2</td>
<td>42342</td>
<td>3</td>
<td>32</td>
</tr>
</tbody>
</table>

**Source: Ali Auto, 2018-02-01**

**Battery production**

In 2017, the overall installed capacity of EV and PHEV battery production reached 36.2 gigawatt hours (GWh), up 29% from 28 GWh in 2016, according to Shenzhen Gaogong Industry Research Co., Ltd (GGHI). The biggest manufacturer was Chinese CATL, with a total installed battery capacity of just under 10.6 GWh, nearly 30% of the overall industry capacity. It was followed by BYD Auto, with an annual installed capacity of almost 5.7 GWh. In terms of battery type, lithium-iron phosphate (LFP) batteries took up 50% of 2017 power battery

⁴ Ali Auto, 2018-02-01
deliveries, ternary lithium-iron batteries 45%, while lithium-manganese spinel (LMO) and lithium titanate (LTO) represented 4% and 1%, respectively, of the total deliveries.\(^5\)

**Charging facilities**

The number of public charging points for electric vehicles in China grew by 51% year-on-year to 214,000 in 2017, and just over double that, around 450,000, if private charging points are counted. Although this gives China the largest number of public NEV charging stations in the world, the ratio of EVs to charging point is as high as 3.8:1.\(^6\)

**A deeper look at China’s EV industry using Porter’s diamond model**

Professor Michael Porter\(^7\) puts forward a dynamic model of international competitiveness, explaining why some industries in a country will be strongly competitive on the international market, and sums up the six factors that can affect the competitiveness of a country’s industries; namely, factors conditions, related and supporting industries, demand conditions, corporate strategy, market structure and competitors, governments and chances. These six factors make up the Porter diamond model shown in the figure below. We will use this model to analyze the forces behind the fast growth of China’s EV market.

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\(^5\) Shenzen Gaogong Industry Research Co., Ltd (GGII), 2017

\(^6\) Xinhua, 2018-01-21

\(^7\) Porter, 1990
Figure 4. The Porter diamond model

Source: Porter, M., 1990

Factor conditions

Natural resources

Lithium: Lithium-ion batteries are currently the most widely used in plug-in electric cars. China has among the highest lithium reserves in the world, according to Lithium Today\(^8\). 77% of the lithium resources held in the country are to be found in The Qinghai salt lakes in western China. Despite commercial investments, however, there has been no significant lithium production from this source. This can be explained mainly by the fact that sources in South America are more favorable due to their chemistry\(^9\). This explains why China only contributed to 7% of the world’s lithium production in 2017\(^10\), even with its reserve mass\(^11\).

\(^8\) Lithium Today, 2017
\(^9\) Lithium Today, 2017
\(^10\) According to own calculations, based on China’s lithium production compared to the total world lithium production
\(^11\) Investing News, 2018
At the same time, China is globally the largest lithium consumer, in large part because of its EV industry\textsuperscript{12}.

**Figure 5. Countries with the largest lithium reserves worldwide, 2017 (metric tons)**

![Countries with the largest lithium reserves worldwide as of 2017 (in metric tons)](source)

*Source: Statista 2018*

**Graphite**: Lithium-ion batteries for EVs require not only lithium, but also two electrodes: a cathode, usually made with metals such as nickel and cobalt, and a graphite anode\textsuperscript{13}. In 2016, China had the world’s largest graphite production, with a yearly production of 780,000 metric tons (MT)\textsuperscript{14}. According to the U.S. Geological Survey\textsuperscript{15}, the country accounted for 66\% of world graphite production last year, and 35\% of world consumption.

**Rare-earth metals**: There is an increasing demand for rare-earth metals that can be used in electric-vehicle motors, in which typically neodymium and praseodymium are used. In 2016,

\textsuperscript{12} Lithium Today, 2017 & Investing News, 2018  
\textsuperscript{13} Buqa et al, 2005  
\textsuperscript{14} Investing News, 2017  
\textsuperscript{15} US Geological Survey, 2017
China’s rare-earth industry produced 105,000 MT of rare-earth metals, which makes the country’s rare-earth industry the largest in the world.\(^{16}\)

**Labor, capital and infrastructure**

China ranks in top third globally in terms of human capital, according to the *Readiness for the Future of Production Report 2018* by the World Economic Forum\(^{17}\), though the notion of Chinese labor as cheap is now only partially true, and very dependent on the countries with which it is compared. Chinese factory workers were in 2016 on average paid $3.60 per hour, up 64% from 2011, according to market-research firm Euromonitor\(^{18}\). This is more than five times the average hourly manufacturing wage in India, but still around 35% lower than wages for factory workers in developed markets\(^{19}\).

China is also rich in venture capital. In 2016, a decade-long Chinese venture-capital boom reached $50 billion in firm commitments, for the first time almost matching the U.S.\(^{20}\). The EV industry is seen and marketed as a good destination for venture capital and other types of investments, with 450 billion yuan invested into 70 electric-vehicle projects in 2017\(^{21}\).

China has invested a lot in its infrastructure over the last decades. According to the BBC\(^{22}\), China spent 8.6% of its GDP between 1992 and 2013 on the construction of roads, railways, seaports and other transport infrastructure, compared to 2.5% for western Europe, and the same figure for the U.S. and Canada together.

**Related and supporting industries**

Having surpassed the U.S. in 2010, China’s manufacturing sector is now the largest in the world, with a total global Manufacturing Value Added (MVA) of close to USD 3 trillion in 2016, representing approximately one-quarter of the global MVA\(^{23}\). While China is a leader in terms of the scale of its production base, what is being produced is still not as complex as in leading developed nations; China ranks as the world’s 26th most-complex economy\(^{24}\). China’s auto-parts industry is not an exception. There are over 10,000 Chinese factories supplying automobile parts\(^{25}\), but only a few of them can produce complex key parts for internal combustion cars, such as engines and gear boxes. Such parts are only available from foreign companies or their joint ventures with local Chinese companies. The key parts for EVs, such as

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16 Bohlsen, M., 2017-11-14
17 World Economic Forum, 2018
18 CNBC, 2017-02-27
19 Zhang, 2014
20 Venture Beat, 2017-10-14
21 China Association of Automobile Manufacturers, 2017-12-08
22 BBC, 2016-06-20
23 World Economic Forum, 2018
24 Center for International Development at Harvard University, Atlas of Economic Complexity
25 Forward Industry Research Institute, 2017
batteries, motors and electric control-system products can however be produced by local suppliers\textsuperscript{26}.

**Demand conditions**

China has remained the world’s largest automotive market since 2009. A total of 28.88 million cars were sold in 2017, including 24.72 million passenger cars\textsuperscript{27}. While this is due to the fact that, over the last decade, many more Chinese have become owners of passenger cars, the rate of motor vehicles per capita is still at a relatively low level compared to for example Sweden and the U.S.\textsuperscript{28}. This means that there is still much room for demand increase, or - depending on policy - room for alternative routes for the future, where public transport, shared mobility and other solutions take a larger share of total mobility.

Current projections from China’s Ministry of Industry and Information Technology\textsuperscript{29} are that new car sales will reach 35 million in 2025. Of these, 20% should be NEVs, in line with the short-term target of 8% for 2019 and 10% for 2020, as announced by the Ministry of Industry and Information Technology\textsuperscript{30}.

**Corporate strategy, market structure and competitors**

There are hundreds of EV manufacturers that are producing thousands of car models in China. Only those that meet certain requirements can be listed on the Ministry of Industry and Information Technology’s recommendation list and are eligible for incentives. 3,233 vehicle models from 224 companies are on the 2017 version of the list\textsuperscript{31}. Yet 65% of the market is dominated by the top 10 manufacturers, with the top two taking around 20% each. BJEV sold the most battery EVs, while BYD Auto had a focus on plug-in hybrid EVs\textsuperscript{32}.

\textsuperscript{26} China National Energy Administration, 2017-01-16
\textsuperscript{27} Data from China Association of Automobile Manufacturers
\textsuperscript{28} A compilation is available on Wikipedia, [https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita](https://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita)
\textsuperscript{29} Ministry of Industry and Information Technology of the People’s Republic of China, 2017
\textsuperscript{30} Securities Times, 2018-03-09
\textsuperscript{31} CN Auto News 2018-01-04. Original data from Ministry of Industry and Information Technology
\textsuperscript{32} Online Car Market, 2018-01-16. Original data from China Passenger Car Association
Government subsidies

Subsidies from central and local departments are currently playing a vital role for the development of the emerging EV industry in China, as well as on other markets. The Chinese government first decided to support the development of NEVs in 2009 and started to provide a purchase-incentives pilot in 2010. The latest incentive plan for purchase of NEVs was published in April 2015.33

Table 2. Purchasing incentives for NEVs (in thousand yuan)

<table>
<thead>
<tr>
<th></th>
<th>Range, km</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEV</td>
<td>100 -- 150</td>
<td>25</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>BEV</td>
<td>150 -- 250</td>
<td>45</td>
<td>36</td>
<td>36</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>BEV</td>
<td>250+</td>
<td>55</td>
<td>44</td>
<td>44</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>PHEV</td>
<td>50+</td>
<td>30</td>
<td>24</td>
<td>24</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>


33 National Development and Reform Commission, 2016
There are three characteristic traits of the Chinese incentives for electric cars:

1) **The subsidy is range-related - to a point.** BEVs with a range of less than 100 km do not qualify for any subsidy, while at the other end of the scale, there is no added incentive for BEVs with a range of more than 250 km.

2) **Plug-ins get less support**, and low-range PHEVs get nothing. While on some markets, BEVs and PHEVs are treated equally, in China the PHEV support is substantially lower, and most PHEVs - with an electric range of under 50 km - fail to qualify.

3) **The subsidies will be reduced.** Early buyers of BEVs and PHEVs receive a government bonus about two thirds larger than the buyers in 2019-2020.

In addition to this, NEVs are exempted from the 10% purchase tax on new vehicles, with a maximum total financial incentive per vehicle of 60% of the vehicle’s price. To get the tax exemption, purchasers must choose from a list of vehicle models decided by the Ministry of Industry and Information Technology. The version published in September 2017 includes 417 BEV models, 68 PHEV models and 1 FCEV. For the purchase incentives, a similar list exists, but it is shorter; 235 BEV models, 13 PHEV models and 3 FCEVs are included in this list, published by the ministry at the same time.

In 2017, the tax exemption was extended to the end of 2020, which has also been the deadline for other incentives, with declining subsidies from 2018. The subsidies are to be replaced with a quota system for new-energy vehicles, starting from 2019. Under this system, companies making cars with fossil-fuel engines must generate NEV credits through sales of EVs and hybrids or buy the credits from other manufacturers, with a surplus stemming from the sales of more NEVs than the requirement.

In addition to the central incentives, local governments will normally provide the same amount of financial incentives, as well as supporting non-financial incentives such as free parking.

**Conclusion**

EVs are helping with China’s sustainable development in all three aspects; economic, ecological and social. BEVs have no tailpipe emissions and contribute to reducing environmental pollution, while overall emissions reductions help China reach its Nationally Determined Contribution climate target, as presented to the Paris Climate Agreement. Economically, EVs may help reduce the cost of mobility, while at the same time helping the Chinese manufacturing industry to become more internationally competitive than it has been with ICEs (internal combustion engine vehicles). This all puts the Chinese interest and focus on NEVs into perspective, and may help explain why it is likely the focus will be sustained over time, albeit with changing incentives and targets.
Fact box 1: China EV100: A sign of Chinese commitment

A sign of the Chinese commitment to New-Energy Vehicles is the establishment in 2014 of the China Committee of Electric Vehicles 100 Members, known as China EV100. It calls itself “the third-party think tank in Chinese electric vehicle area” but is strongly linked to the government. EV100 holds annual meetings at the Diaoyutai State Guesthouse, where President Xi Jinping meets his counterparts, and its members include five ministers from the central government, including Dr. Wan Gang, Minister of Science and Technology, who used to work as an engineer in German Audi Corporation. EV100 is dedicated to advancing the research, development and deployment of New-Energy Vehicles in China, with more than 140 elite members across different industries and fields, from government departments, academic and research organizations, manufacturing and supplier companies related to electric vehicles. EV100 also actively promotes international cooperation: the Sino-British Auto Innovation Forum and Sino-German Auto Industry Summit were parts of the third China EV100 forum which was held in late January 2018.


Center for International Development at Harvard University, n.d. Atlas of Economic Complexity. Available at: http://atlas.cid.harvard.edu/rankings/


China Association of Automobile Manufactures, 2017-12-08. News article. Available at: http://www.caam.org.cn/hangye/20171208/1005213857.html


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Ministry of Industry and Information Technology of the People’s Republic of China, 2017. Mid- and long term development plan for the automotive industry. Available at: http://www.miit.gov.cn/n1146295/n1146562/n1146650/c5600446/content.html


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