

Comparison of the electric car market in China and the United States

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Introduction

In 2017, global electric passenger car sales passed one million units, and approximately every seven out of ten of them were sold in China or the United States (EV Volumes, 2018). As the two largest national electric vehicle markets, the countries both have a remarkable electric car growth over the past few years and very dynamic market environment.

This briefing, part one of a two-paper series, compares the market and technological characteristics of electric cars in China and the United States, based on 2015 and 2017 data. It

intends to shed light in the uniqueness and similarities in the two market, and show their market characteristics and trends over the three-year period. It also acts as an update to our 2015 report (He, Jin, Cui & Zhou, 2018) on the electric passenger vehicle market in China.

The new vehicle registration data was obtained from industry websites, two previous ICCT papers (Lutsey, Slowik & Jin, 2016; Slowik & Lutsey, 2018) and the China Automotive Technology and Research Center. These data contain national aggregate data and detailed local data for major U.S. metropolitan areas and over 300 Chinese cities.

The analysis focuses on passenger electric vehicles (interchangeably with electric car).

Market characters of electric cars in the U.S. and China

OVERALL MARKET TREND

Both nations experienced remarkable growth of electric car sales in the past decade. The U.S. market took off in early 2010s, approximately two years earlier than in China. But China's market grew at much faster pace, especially after 2014. The growth rate in the United States slowed down after 2013 compared to the previous two years but remained steady.

Since 2013, China has accomplished a phenomenal growth of new energy vehicle (NEV) sales, namely battery electric (BEV), plug-in hybrid electric (PHEV), and fuel cell vehicles (FCVs). With an annual growth rate of at least 45% for six consecutive years from 2012 to 2017, China emerged as an evident leader among major electric vehicle markets globally. In 2017, new electric car sales in China reached over 500,000. It contributed to almost half of the total sales worldwide, and more than twice the sales in the U.S. In the U.S., growth in NEV sales remained steady at between 20% to 30%, with the total sales of around 190,000 in 2017.

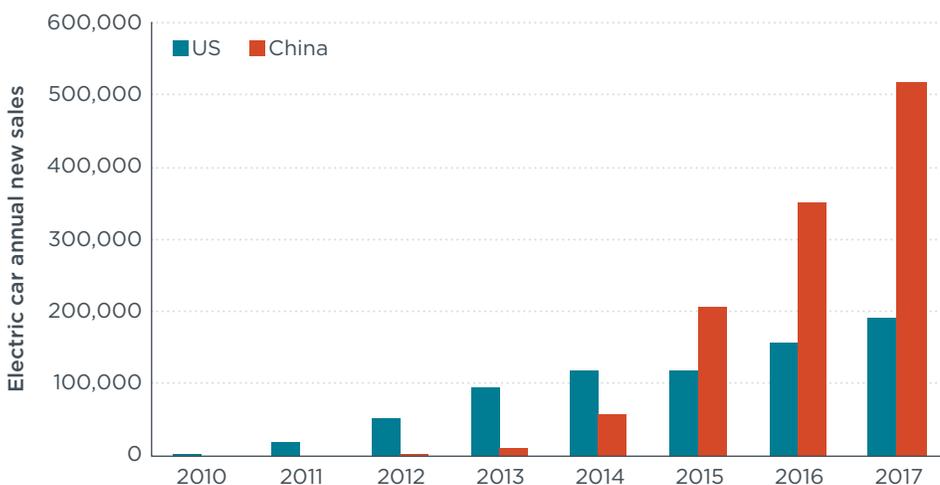


Figure 1. Historical annual sales of plug-in electric passenger vehicles in China and the United States (2010–2017). Sales data is based on EV Sales (2018); EV Volumes (2018); Hybridcars (2018); CAAM (2018).

Electric car sales and market share in leading Chinese cities

The thirty leading cities in electric car market share in China and the United States based on 2015 and 2017 data are shown in Figure 2. In both markets, the majority of the electric car sales are concentrated in a small number of cities. In China, the top 30 cities collectively represented 72% of the total national electric car market in 2017, while contributing to only 36% of the passenger vehicle sales in 2017. In the United States, the top 30 cities made up about 74% of the total electric car sales, while contributing to 42% of the

passenger vehicle sales in 2017. These numbers were similar in 2015.

More leading cities had a higher electric car market share in China than in the United States, while China’s national average uptake was slightly lower in 2017. The average market penetration of electric cars in these cities is approximately 4.5% and 2%, significantly greater than the national average of 0.9% and 1.2% in China and the United States, respectively.

The leading cities in the United States have remained relatively consistent, with the only change being the two cities on lower part of the list:

Providence and Kansas City joined the list in 2017, while Indianapolis and Dallas dropped out. In China, seven cities changed between the two years. For example, Taiyuan and Dalian dropped out of the list and Lanzhou and Baoding were added in 2017. One caveat is Weifang, who ranks high in the list in 2017. The insurance data on which the sales number are based do not properly reflect the sales in that city, and the real sales number are lower. This is due to the difference in subsidies in different provinces. Dealers in Shandong, which had no subsidies, chose to get insurance locally but obtain license in other places in order to obtain subsidies.

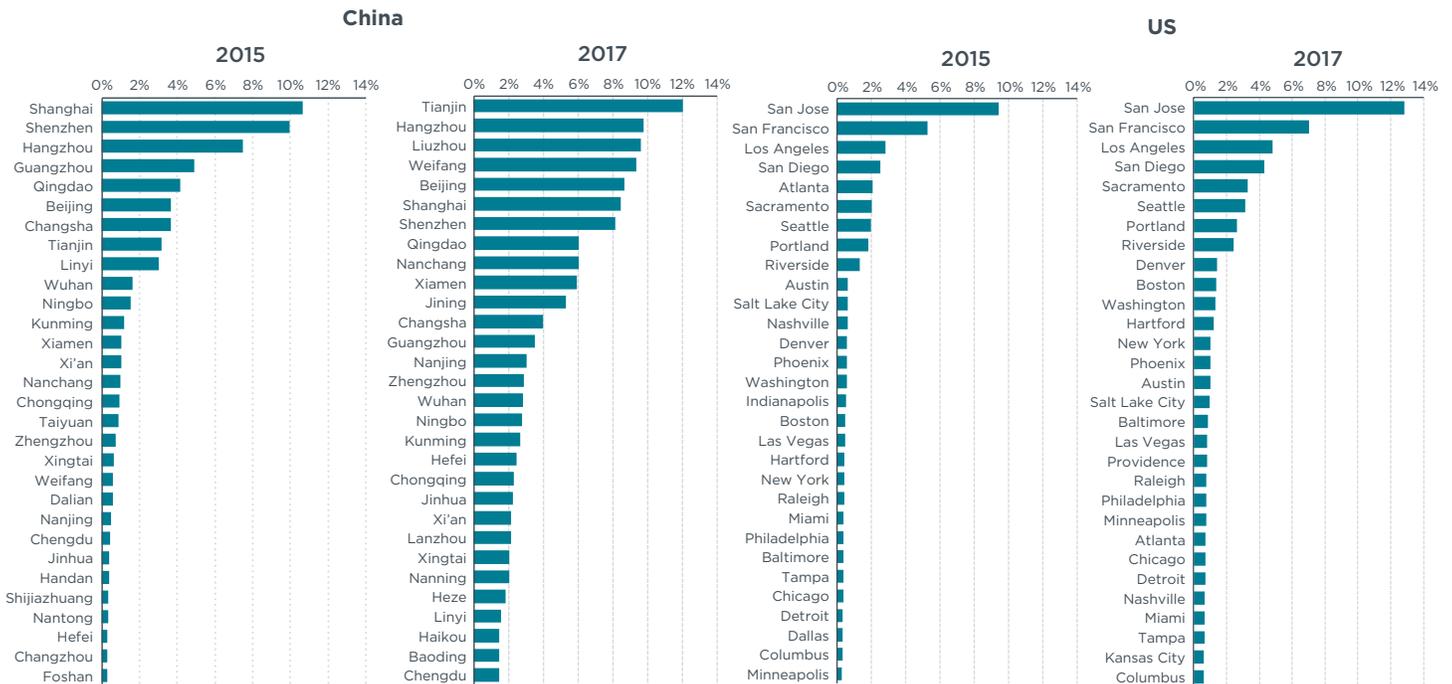


Figure 2. Electric car market share in the top 30 cities in China and the United States, 2015 and 2017. For China, cities with over 100,000 electric vehicle sales are shown to exclude small cities with only a few electric vehicles but a relatively high share.

MARKET SHARE BY BRAND

In both countries, a small number of brands contribute to the majority of the electric car market share. Less than 10 brands made up 90% or more of the total electric car market share in both countries in both years. In China, these are all domestic brands (some formed joint ventures with foreign brands), while the U.S. is more open to international brands.

In 2015, there were 23 electric car manufacturers in China, with the 9 largest making up about 90% of the total sales (Figure 3). In 2017, although the total number of brands increased to 34, the 9 largest companies still made up about 89% of the total sales. In 2017, BAIC overtook BYD and became the leading brand, and traditional vehicle manufacturers such as Dongfeng and Changan started to take up a larger electric vehicle market share. Some Zhidou vehicles were produced under Geely and others under Jiangnan in 2017. In addition, Zotye was registered under Jiangnan and Kandi was registered under Geely. These changes are probably due to strategy changes within an auto group or partnership.

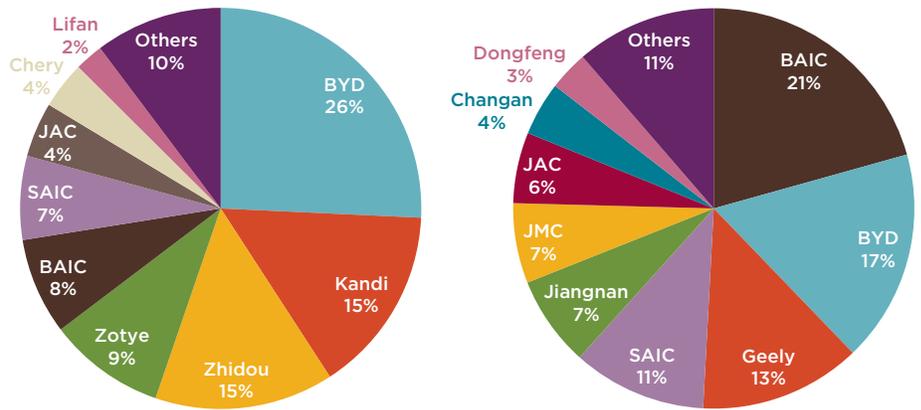


Figure 3. Electric car brand market shares in China, 2015 and 2017.

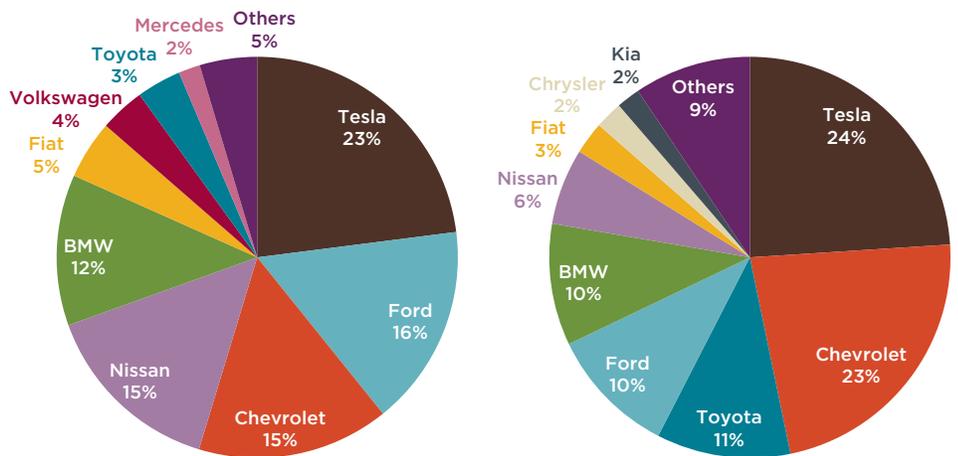


Figure 4. Electric car brand market shares in the United States, 2015 and 2017.

In the United States, Tesla remained the leading brand in both 2015 and 2017, with about a quarter of the total market share (Figure 4). Chevrolet moved from third to second place in 2017, with about half of its sales coming from its Bolt model. Toyota acquired a market share of 11% in 2017 with its Prius Prime, up from only 3% in 2015, ranking behind Chevrolet. Nissan, BMW and Ford all lost some

market share in 2017 compared to 2015, and Volkswagen and Mercedes dropped off of the top 9 list.

In China, conventional vehicle manufacturers, such as BAIC, SAIC, BYD, JAC and JMC, account for most of the electric car market share. There are a number of new electric vehicle manufacturers emerging, such as Yudo, which focuses on battery

electric SUVs. Its π1 has been very popular among consumers since its release. Technology companies are also entering the electric car market, sometimes choose to partner with traditional vehicle manufacturers. For example, Xiaopeng Automotive Technology was the first technology company to be able to mass-produce electric vehicles with a partnership with Haima.

LEADING MANUFACTURERS BY REGION

Figure 5 shows the market share of specific electric vehicle manufacturers in each province or state in 2017. Regional China and U.S market share by manufacturer show very different patterns. In China, manufacturers tend to take up a larger share of the market in a province if their headquarters or manufacturing plant is located there. Examples are BAIC in Beijing, BYD in Guangdong, Geely in Zhejiang, JMC in Jiangxi and SAIC in Shanghai. This dynamic is not as important in the United States, as both domestic and foreign automakers have strong nationwide distribution and dealership networks. One exception is Tesla, which is more concentrated on the West Coast possibly because it is a new company. Some manufacturers performed well in all markets, such as Tesla and General Motors; some had slightly larger share in selected states, for example, Toyota and Ford; and others had a small market share in all the markets, such as Hyundai-Kia and Mercedes.

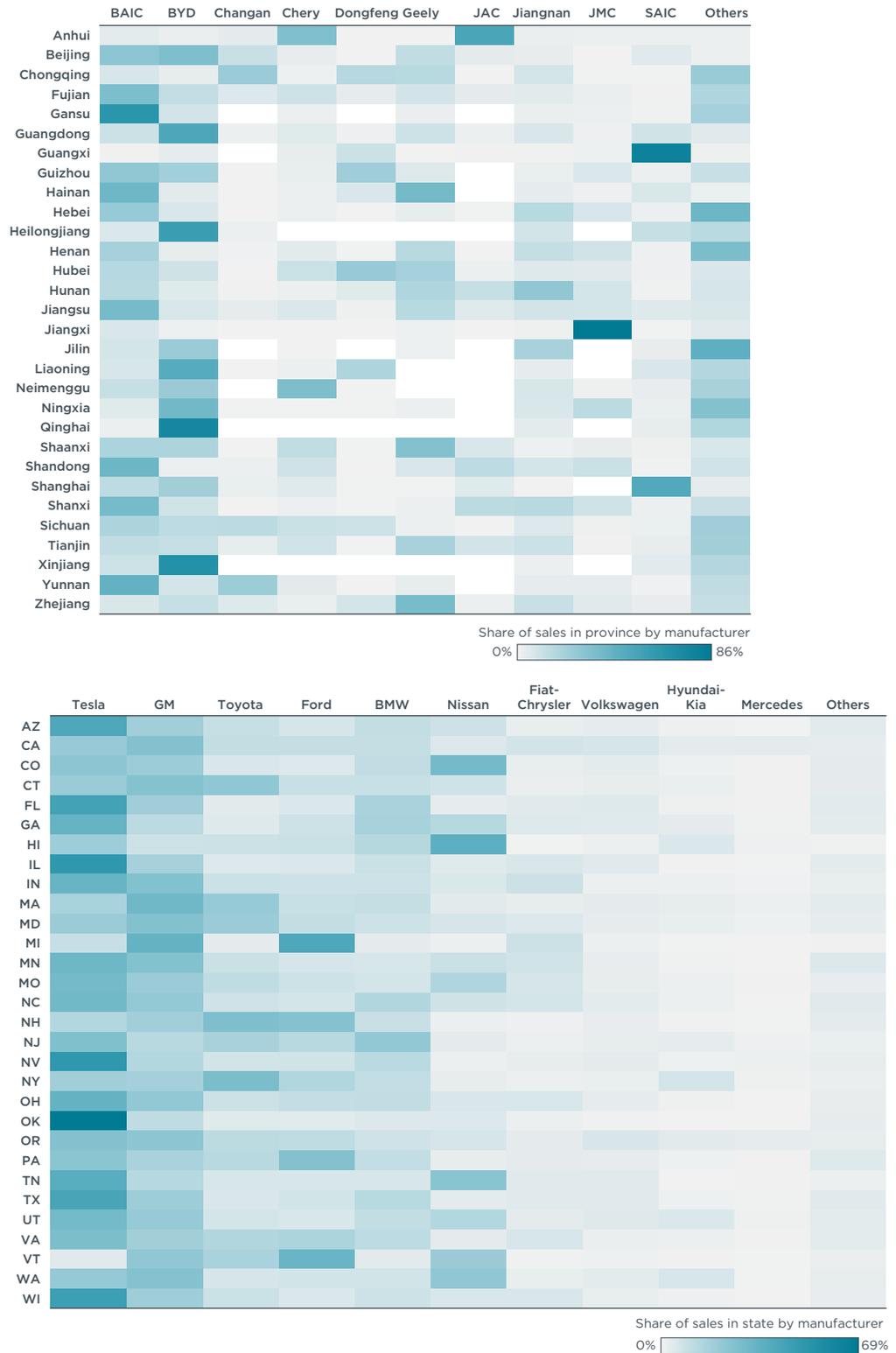


Figure 5. Top 30 provinces/states in total sales and their market share by manufacturer in China and United States, 2017. Color is indexed to the market share number, with lighter colors representing smaller market share.

MARKET SHARE BY TECHNOLOGY PATH

In China, the sales and model availability of BEVs are far greater than PHEVs, but there is not a significant difference in the market development of these two technologies in the United States.

As a result of China’s promotion of BEVs as a major strategy in the restructuring of the automobile industry, their sales and availability far outweighing PHEVs. As shown in Figure 6, BEV sales were more than twice the sales of PHEV in China, and the number of BEV models in the market was more than five times that of PHEV’s in 2015. The consumer preference for BEVs grew in 2017 with 83% of sales being BEVs and 17% being PHEVs. The difference in model availability between BEVs and PHEVs got smaller in 2017 (Figure 8). The very small number of FCVs comes from SAIC’s Roewe 950, with its limited production and sales in Shanghai.

In comparison, although some U.S. states and cities offer incentives for BEVs and PHEVs., the two technologies had comparable sales and model availability (Figure 7 and Figure 9). The U.S, PHEV market grew in in model availability and sales between 2015 and 2017. In 2017, BEV and PHEV approximately split the market share evenly, but the model availability of PHEV outweighed that of BEV’s.

At the city-level, the sales of BEVs outweighed that of PHEVs in 27 out of the 30 target cities in China in 2015. The sales of PHEVs were more than BEVs only in Shanghai, Shenzhen, and Xi’an. These cities all have local PHEV

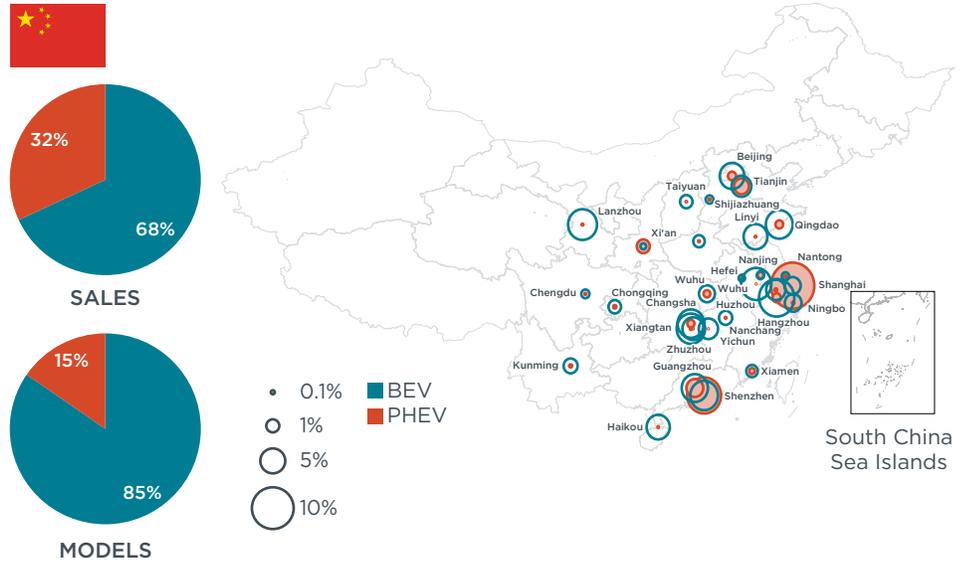


Figure 6. New 2015 plug-in hybrid and battery electric car shares in 30 leading Chinese cities.



Figure 7. New 2015 plug-in hybrid and battery electric car shares in 30 leading U.S. metropolitan areas.

manufacturers, with SAIC in Shanghai, BYD in Shenzhen and one of BYD’s major manufacturing base in Xi’an. In 2017, only Shanghai and Shenzhen had higher sales in PHEVs than BEVs, and

the difference was less remarkable than in 2015. Most of the U.S. target cities had similar shares of BEVs and PHEVs in 2017. Only San Jose shows a slightly higher PHEV share than BEV.

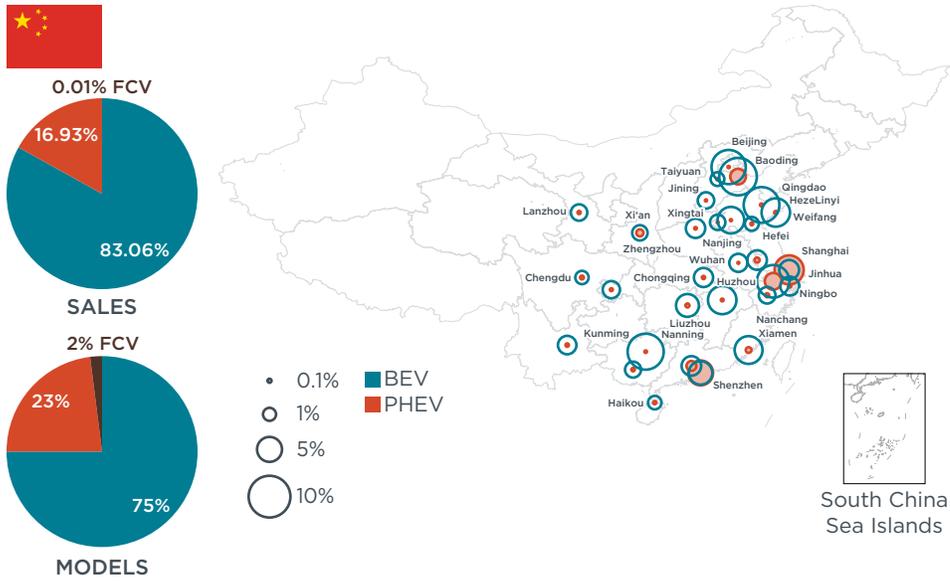


Figure 8. New 2017 plug-in hybrid and battery electric car shares in 30 leading Chinese cities.

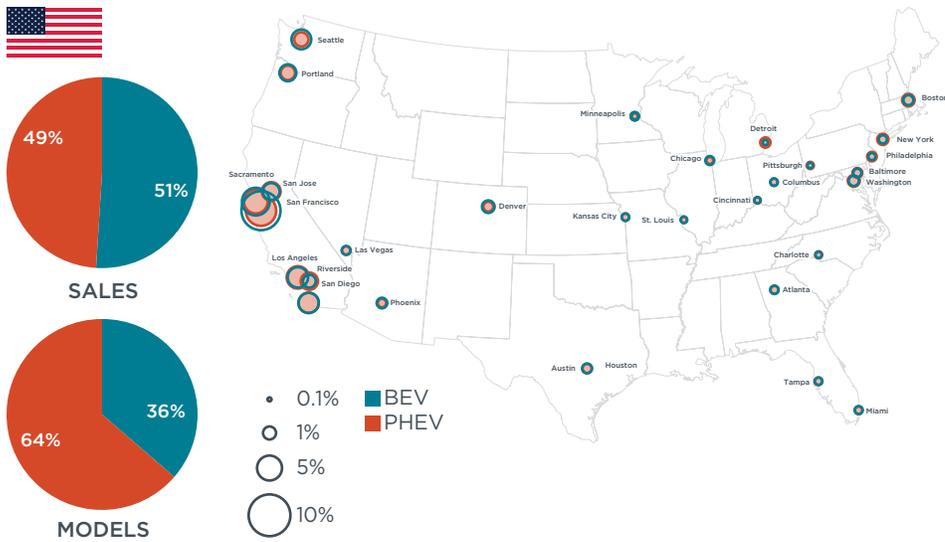


Figure 9. New 2017 plug-in hybrid and battery electric car shares in 30 leading U.S. metropolitan areas.

MARKET SHARE BY VEHICLE SEGMENT

Figure 10 through Figure 13 illustrate the China and U.S. BEV and PHEV markets in 2015 and 2017, categorized by vehicle size.¹ In China, the BEV sector was dominated by microcars, which are often cheaper and have a shorter electric range than other models. In 2017, approximately 68% of BEV sales were microcars. Cars accounted for 27%, and SUVs, MPVs and vans took up the rest 5%. The numbers are similar in 2015. The vehicle segment composition of the PHEV sector looked similar to that of the U.S., with over 75% of sales being cars and the rest being SUVs.

In contrast, the market segments for both battery and plug-in hybrid vehicles are similar in the United States, with cars contributing to over 80% of the total sales.

SUVs took up a larger portion of the PHEV market in China than in the United States. Three SUV models, the SAIC Roewe eRX5, the BYD Song, and the BYD Tang, represented over half of the PHEV sales in China in 2017. In the U.S., SUV models only accounted for about 15% of the total PHEV sales in 2017.

There are many more players in the BEV market than the PHEV market in China, while in the U.S. the difference is not so significant. The ten most popular BEV models were 59% of the BEV sales in China in 2017, while in the United States, the top ten BEV models represented approximately 97% of the total sales. In contrast, the

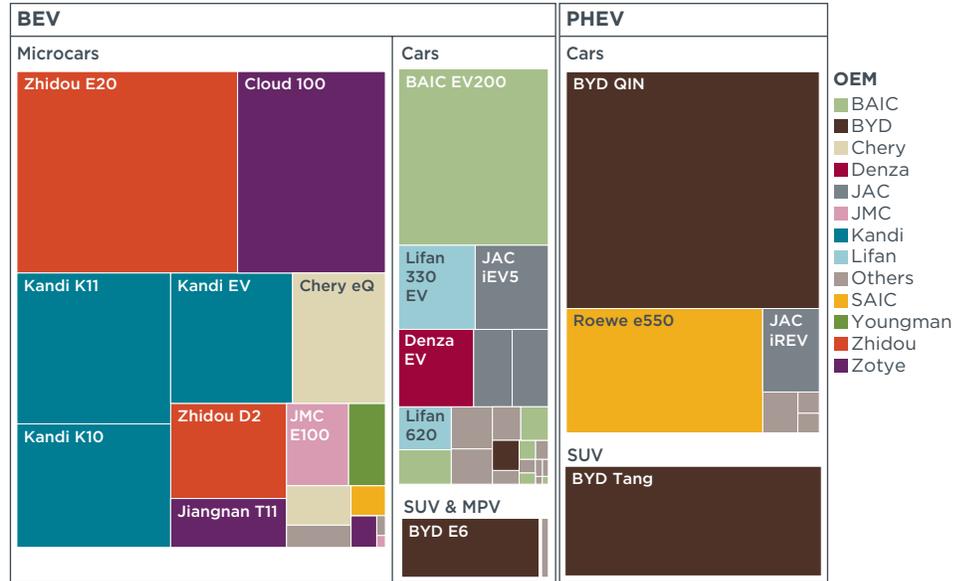


Figure 10. Vehicle segments of BEVs and PHEVs by sales in China, 2015.

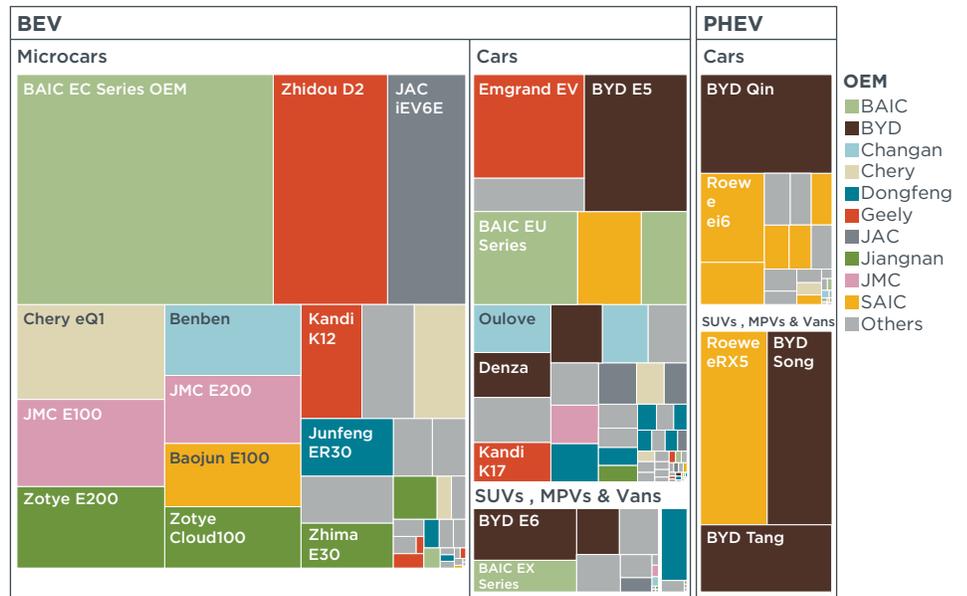


Figure 11. Vehicle segments of BEVs and PHEVs by sales in China, 2017.

PHEV market was dominated by a few brands in China, namely SAIC and BYD, which contributed to over 90% of the total PHEV market share in both 2015 and 2017.

In 2017, both the BEV and PHEV markets in China became more fragmented in 2017, with the previously dominant brands taking up less market share.

The market share of the top ten BEV models decreased from about 80% to 59% in 2017 in China. More players and models emerged and became popular, such as the several models from BAIC, JMC and JAC. For PHEV, although BYD and SAIC still dominated the market, there were more model availability, and SAIC eroded BYD’s dominant market share. The U.S. market tends to

¹ The passenger vehicles are categorized into three major segments: microcars, cars and SUV, and MPV and vans, based on the common Euro car segment used in China. Cars are divided into six segments from A to F, with generally increasing wheelbase, engine displacement and other metrics. The A segment is further divided, with those with a wheelbase smaller than 2.3 meters (A00) classified a microcar.

be steadier, with a bit more offerings in the PHEV sector in 2017.

The market share of the SUV segment grew for both PHEV and BEV in 2017 from 2015 in both countries. In China, the market share of SUV, MPV and vans in 2017 was 14%, this is an increase from 10% in 2015. The growth in the United States. was more significant than in China: the market share was 2% in 2015 and grew to 16% in 2017.

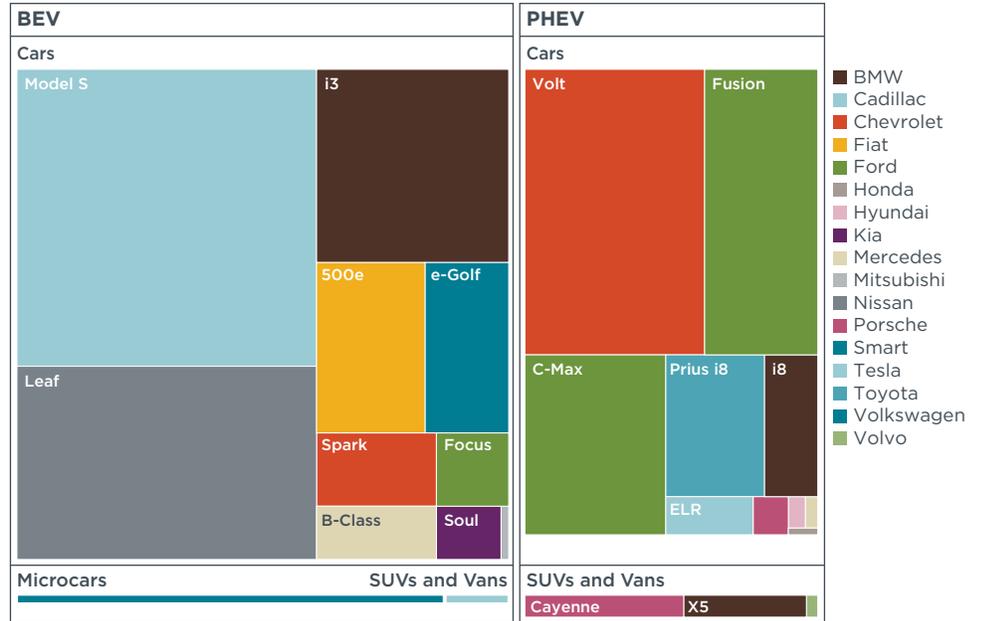


Figure 12. Vehicle segments of BEVs and PHEVs by sales in the United States, 2015.

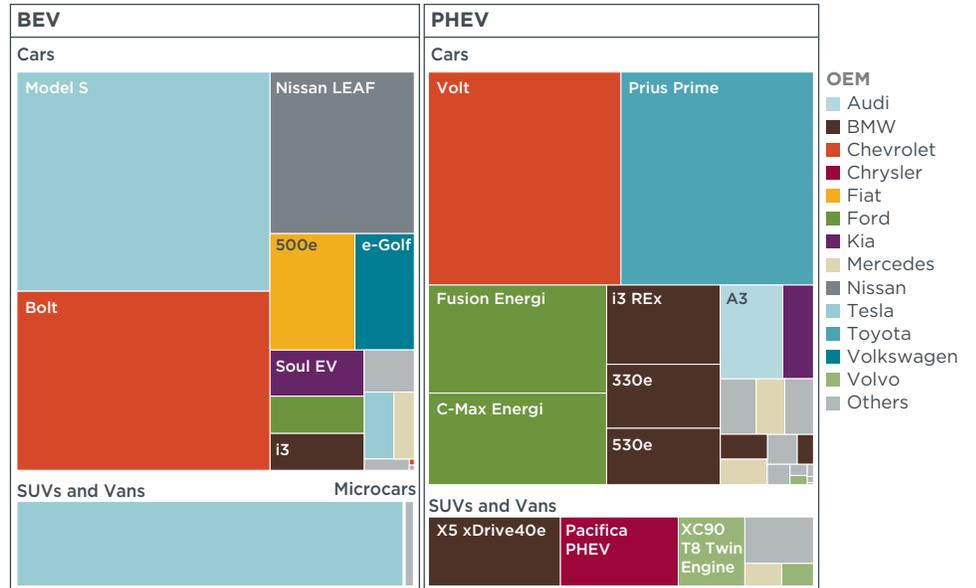


Figure 13. Vehicle segments of BEVs and PHEVs by sales in the United States, 2017.

MODEL AVAILABILITY

Better model availability gives consumers more choices and can increase competition in the electric vehicle market. It is often seen as an important factor in electric vehicle market uptake. Figure 14 and Figure 15 show the relationship between model availability (x axis), market share (y axis) and market size (circle size) in the United States and China in 2017.² Data from 2015 shows similar patterns.

There is no clear link visually between model availability and electric vehicle market share in China. Cities with higher market share and sales, such as Tianjin, Hangzhou, Shenzhen, Shanghai, and Beijing tend to have more available models, but cities with more models available do not necessarily have high market share. Moreover, there are cities with limited model availability but still have relatively high electric vehicle market share, such as Liuzhou.

In the United States, metropolitan areas with more models available tend to have relatively higher electric vehicle sales and sales share. The top 5 areas by market size, accounting for almost half of the total national sales were also the top 5 in terms of model availability, with 28 to 37 models.

There are generally more models in the U.S. metropolitan areas than the Chinese cities, with an average of 17 and 13, respectively. In addition, the leading 5 cities in China had 19 to 23 models available, versus 28 to 37 models available in the United States.

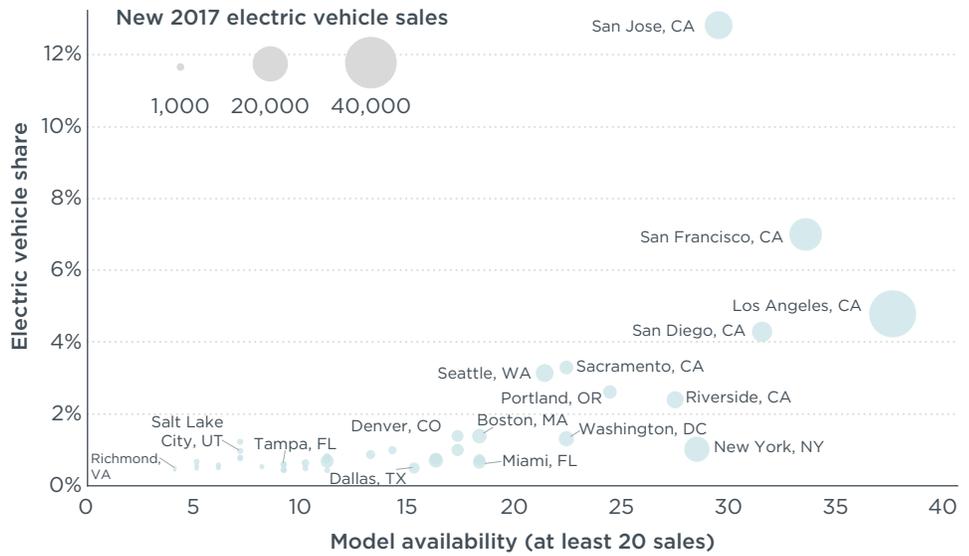


Figure 14. Market share of new electric vehicles and model availability in 30 leading Chinese cities by market share in 2017.

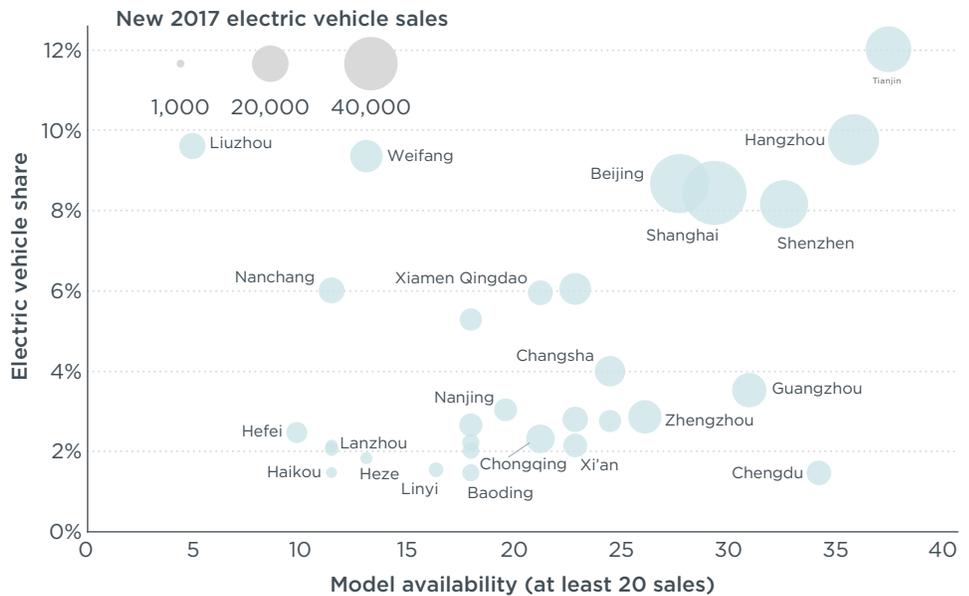


Figure 15. Market share of new electric vehicles and model availability in 30 leading U.S. metropolitan areas by market share in 2017.

² Model availability is defined as the number of models that has at least 20 new registrations to filter out those that are not widely available to the public.

Technical characteristics of electric cars

TOP MODELS

Figure 16 and Figure 17 show the ten best-selling BEV and PHEV models along with their market share in China and the United States in 2015 and 2017.

Consumers in China tend to prefer cheaper and shorter-range microcar BEVs, but plug-in hybrid SUVs, while U.S. consumers prefer cars for both BEVs and PHEVs. The top BEV models tend to have a longer range, and PHEVs tend to have a shorter all-electric range in the United States than in China.

In China, seven of the top ten BEV models in 2017 were cheaper, shorter-range microcars. In the United States, nine of the top ten selling BEVs are all cars, with only one SUV - the Tesla Model X. The three best-selling U.S. models all have longer-than-average range (over 200 miles).

Three SUV models, the SAIC Roewe eRX5, the BYD Song, and the BYD Tang, represented over half of the PHEV sales in China in 2017. In the United States, the BMW X5 xDrive 40e and the Chrysler Pacifica, the only two SUV models in the top ten list, accounted for only about 10% of the total PHEV sales in 2017.

The features of the plug-in hybrid SUV models in the two markets are very different. The BMW X5 offers a very short electric-range at relatively high energy consumption, as a compromise to all the luxury features of the vehicle. Priced at more than \$60,000, it was one of the most expensive models among the top 10 list. The Chrysler Pacifica, the first electric van in the United States, was newly released in 2017 and priced at a little bit over \$40,000. By comparison, all three SUV models in China had a longer all-electric range than the U.S. models and cost less. Both of BYD's models have a 50-mile (80km) all-electric range. The BYD Song is priced as low as around

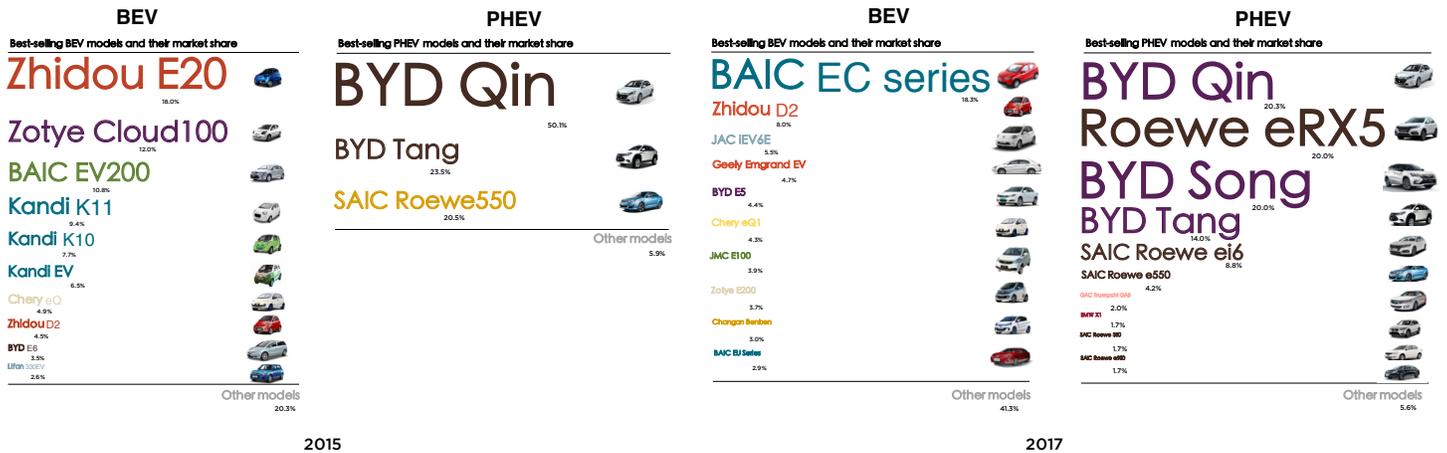


Figure 16. Best-selling BEV and PHEV models in China, 2015 and 2017. Model names with the same color belong to the same manufacturer.

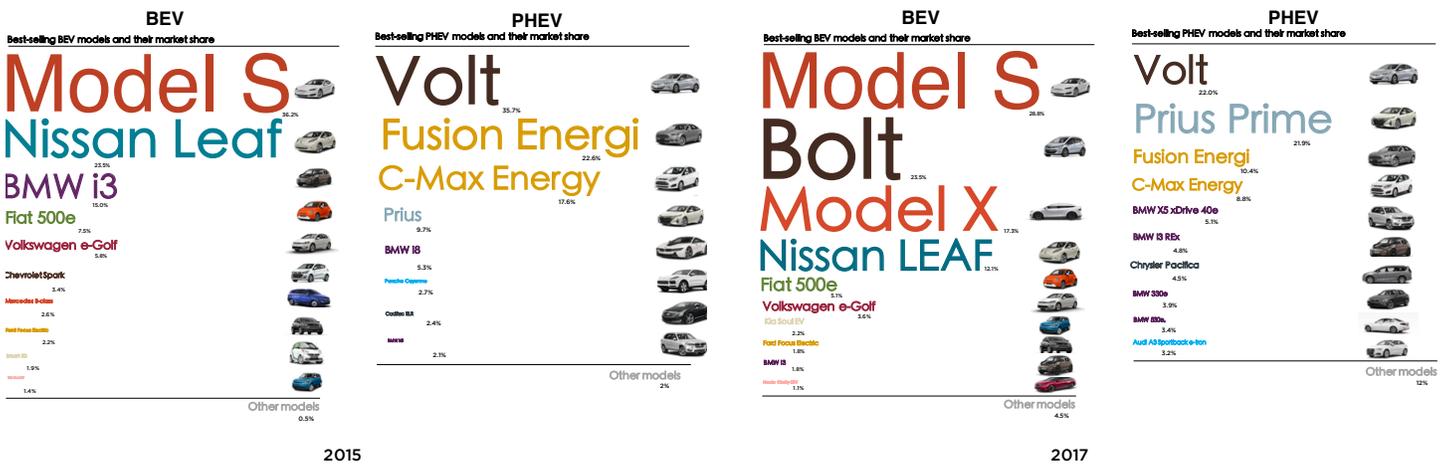


Figure 17. Best-selling BEV and PHEV models in the U.S., 2015 and 2017. Model names with the same color belong to the same manufacturer.

\$26,000 after subsidy and the BYD Tang as low as around \$35,500 after subsidy. The Roewe eRX5 from SAIC has a 37-mile (60km) all-electric range and is priced as low as about \$29,000 after central subsidy.

PERFORMANCE METRICS

The distribution of two technical specifications, electric driving range and battery capacity, of plug-in electric cars in China and the United States are shown in Figure 18 and Figure 19. In both countries, there are more models covering wider performance metrics in 2017 compared to 2015, but the distribution patterns of the metrics differ.

Compared with 2015, there has been major developments in the offerings of battery electric vehicles with different vehicle type and range. In China, although microcars with a range of approximately 100-miles continue to be popular, there are considerable sales in higher-range cars and SUVs. The BYD E6, with an electric range of around 250 miles, became more popular among Chinese consumers. In the United States, there are more models with a range slightly over 100 miles, and at a higher range around 250 miles, such as the Tesla Model X and the Chevrolet Bolt.

Similar to the trend for BEV, in 2017, there were more PHEV models and range to choose from. In China, there were a variety of models ranging from 30 miles to 72 miles in 2017, while in 2015, consumers had a limited choice of PHEV models available, and no model had an all-electric range of over 50 miles. In 2017, In the United States, although the range of most PHEV models is still mostly under 50 miles, there are more models available in 2017.

As shown in the figures below, the distribution pattern of model feature clusters corresponds with the design of the central new energy vehicle

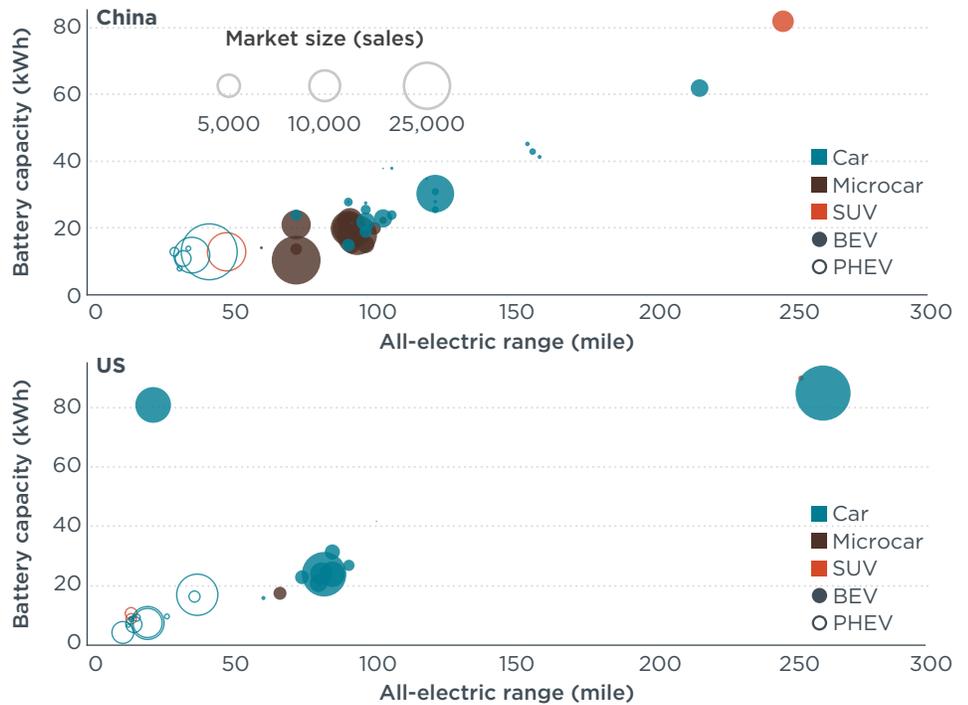


Figure 18. All-electric range and battery capacity of BEV and PHEV models in China and the United States, 2015.

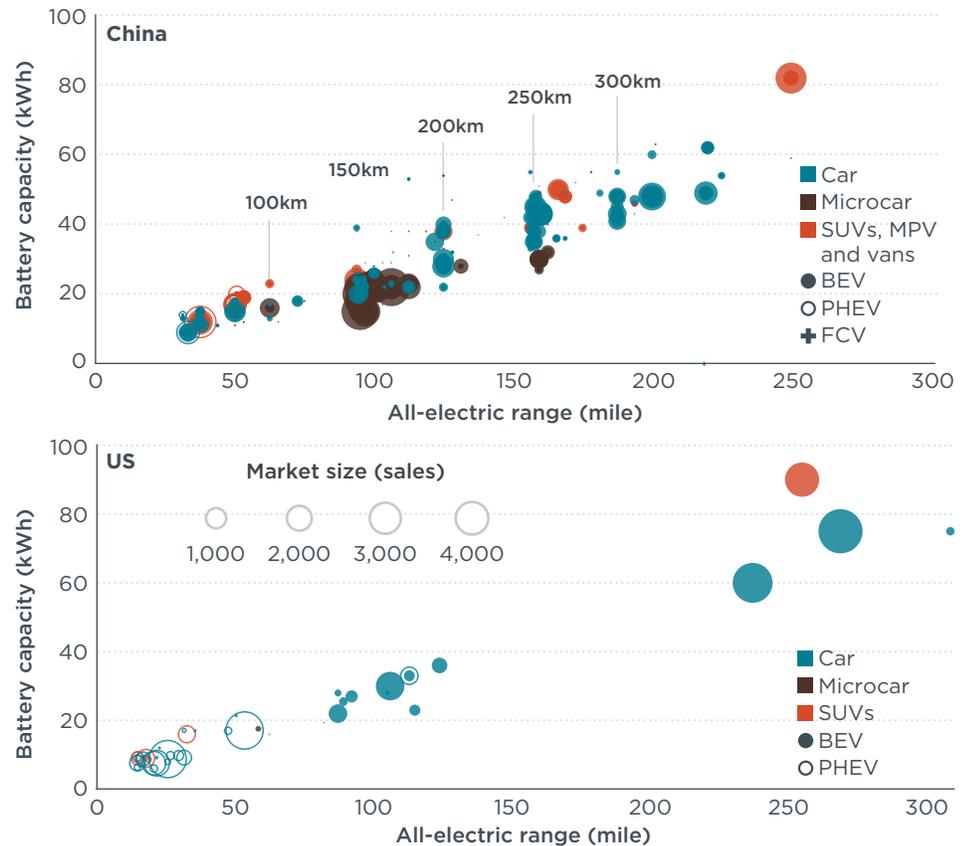


Figure 19. All-electric range and battery capacity of BEV and PHEV models in China and the United States, 2017.

subsidies in China. The Chinese BEVs are clustered at 150km or above, in 50km increments, and PHEVs are shown to have an all-electric range of 50km around 31 miles or more. BEVs are eligible for three subsidy tiers depending on electric range and other performance metrics, and only PHEVs with a 50km all-electric range or above can receive subsidy. For example, a BEV with a minimum range of 150km and a battery energy density between 90 and 120 Wh/kg would receive the second tier of subsidy of 360 thousand *yuan* in 2017. This is a major leap from the first-tier level of 200 thousand *yuan* given to BEVs with electric mileage above 100km with the same battery energy density. The third tier is applied to BEVs with a minimum range of 250km, where there is also a cluster of models slightly above that range.

The U.S. BEV data present a distinct bipolar distribution in terms of electric car driving range, with one peak at around 50-130 miles and the other at around 250 miles primarily driven by the three Tesla models and Chevrolet Bolt. Nothing is available in between. The U.S. federal income tax credit for BEVs scales based on battery capacity. To receive the maximum \$7,500 incentive the vehicle must have a 16kWh battery. All BEVs shown here qualify for the maximum credit. Compared to the Chinese market, U.S. consumers prefer BEVs with longer electric range. Many PHEVs have less than 16kWh battery capacities, and thus are not eligible for the full \$7500 income tax credit. However, many states such as California offer access to high-occupancy lanes to PHEVs, which can be a valuable benefit to some drivers.

In general, manufacturers selling BEVs in China provided a greater diversity of car models in terms of all-electric range than manufacturers selling BEVs in the United States. The overall

electric mileage coverages of battery electric cars in the two markets were very close -- ranging from about 50 miles to up to 300 miles. Compared to the Chinese PHEV market, the U.S. market had more PHEV models with lower all-electric range.

Conclusions

In both Chinese and U.S. markets, consumers in a handful of cities make up the majority of electric car sales, and a few cities are very successful in promoting electric vehicles. The top 30 cities in electric car market share in both countries contribute to over 70% of the total national electric car market in 2017, while making up approximately 40% of the passenger vehicle sales.

In both countries, a small number of vehicle manufacturers contribute to the majority of the electric car market share. Less than 10 brands made up approximately 90% of the total electric car market share in both countries in 2015 and 2017. In China, these are all domestic brands or joint ventures with foreign brands, while a share of the electric and hybrid vehicle sales in the United States are imports. In China, BAIC overtook BYD and became the leading brand in 2017, and traditional vehicle manufacturers such as Dongfeng and Changan started to take up a larger market share. In the United States, Tesla had the most sales of any brand in both 2015 and 2017, taking up about a quarter of the total market share.

Regional market shares by manufacturer in the United States and China present very different patterns. In China, brands tend to perform better in markets where they are headquartered or have a manufacturing facility. In the United States, leading models are similar across states as most

automakers have robust nationwide distribution and dealership networks.

In China, the sales and model availability of BEVs are far greater than PHEVs, while in the U.S. market, there is not a significant difference between the sales and availability of two technologies. This bias in sales towards BEVs increased between 2015 and 2017 in China, while in the United States, the PHEV market grew both in model number and sales.

There are many more manufacturers in the BEV market than the PHEV market in China. Both sectors became more fragmented in 2017, with the previously dominant brands taking up less market share. In the United States, the difference between the two technologies is not so significant, and the market tends to be steadier with a bit more offerings in the PHEV sector in 2017.

Microcars, which are cheaper and have a shorter all-electric range, continue to dominate the BEV market in China. Sales of SUVs took up a larger portion of the PHEV market in China than in the United States. The market share of the SUV segment grew for both PHEV and BEV in 2017 from 2015 in both countries.

There is no clear link between model availability and electric vehicle market share in China, while in the United States, areas with more models available tend to have relatively higher electric vehicle sales and sales share. The United States generally had more models available than China in leading metropolitan areas in 2017, with an average of 17 and 13 models, respectively. This phenomenon was similar in 2015. This warrants further analysis on potential confounding factors and how model availability affects electric vehicle uptake in China.

In both countries, there are more models covering a wider range of

performance metrics in 2017 compared to 2015, but the distribution patterns of the metrics are different in the two countries. In China, the distribution pattern of model clusters corresponds with the design of central subsidy, with BEVs clustered at 150km or above in 50km increments, and PHEVs all having an all-electric range of 50km (around 31 miles) or more. The U.S. BEV data present a distinct bipolar distribution in terms of electric car driving range, with one peak at around 50-130 miles and the other at around 250 miles, primarily driven by the three Tesla models and Chevrolet Bolt. Nothing is available in between. All of the U.S. BEVs analyzed here in both years were designed to receive the maximum federal tax credit, while many of the PHEVs have less than 16kWh battery capacities, and so are not eligible for the full \$7500 credit. Many consumers bought the vehicles for other benefits, such as access to high-occupancy lanes, which is offered by some states.

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