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Feature Report

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China EV – Social, Economics, Politics, and Technology (SEPT)

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China Government Hope Big on EV

Chinese government is hoping for a leapfrog in EV technologies to level the playing ground with developed countries and offered strong supports to local EV players. Yet the cost-conscious car buyers in China are not helping as much as the green life conscious U.S. and EU car buyers.

Chinese Players Hoping for Leapfrog in EV Chemistry

Chinese players adopt a strategy of developing leapfrog technologies in hope of improving its proprietary lithium ion battery chemistry to match leading technologies in key metrics. This combined with their initial success in developing the taxi and car rental markets put BYD in the top spot in annual sales and cumulative sales, until 2019.

China Government Embracing Tesla

In the latest move, China government turns to foreigners and grants substantial concessions in key issues to Tesla to build its Gigafactory 3 as China's first wholly foreign-owned car plant. This may serve as a reflection of the government's broader shift to open up its car market toward foreign players.

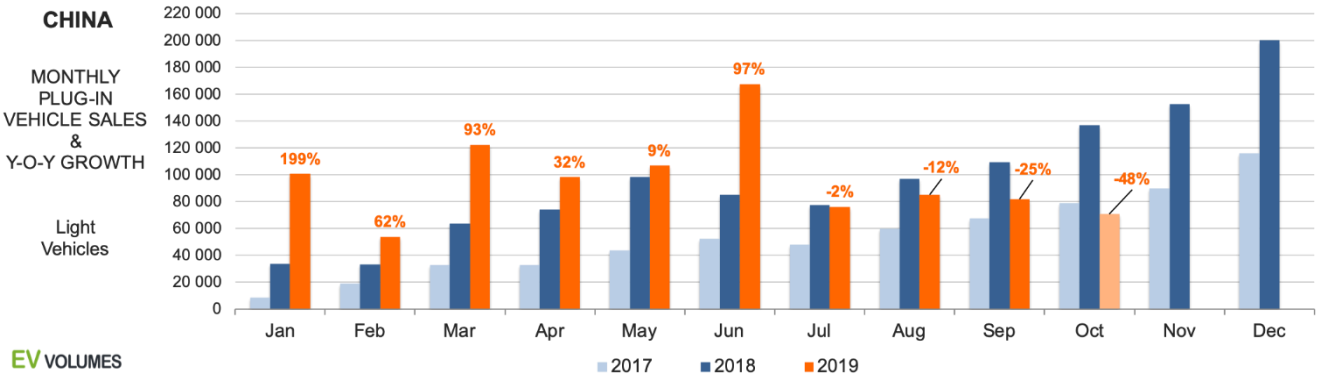
China EV Makers' Last Stand in Long Mileage with LFP Chemistry

China EV makers have to develop and defend to last stand the long mileage segment deploying LFP chemistry. The logic is simple: they have seen the dead end on short range, the inherent deficiency of LFP chemistry, and they should have visualized the potentials in combining the cheaper manufacturing costs of LFP chemistry and long mileage EV. Moreover, news is circulating that Tesla is going that direction. If Tesla succeeds in this segment before China EV makers do, what is left to China EV makers will be nothing.

Overview

China's Electric Vehicle (EV) market has seen a boom in the past few years and apparently reach a plateau, if not hitting the ceiling, in the second quarter of 2019. There is a hope of recovery with the first delivery of Made-in-China (MIC) Tesla Model 3 on December 30, 2019. We analyse the Chinese EV market from the social, economics, politics, and technology aspects under our SEPT framework and look for a turn around strategy for the Chinese EV players.

Exhibit 1: China EV Sales Growth in Negative Since July 2019



Source: ev-volumes.com

It may not be easy for the Chinese EV players, yet they have to defend and develop their turf to survive and thrive.

Social Aspect of SEPT Framework

We look into China EV makers' product offerings and customers' preferences under the social aspect of EV. Tesla, which just launched its locally produced Model 3 in China, is compared to its local counterparts and the car owners' responses to older products will shed light on the situation of the China EV market.

Tesla: Progressive Product Development Strategy

So far, the undisputed leader in EV is Tesla. Its product development strategy is well structured and followers worldwide are not capable to match. Tesla first introduced the stylish sports car Roadster with acceleration from 0 to 60 mph in less than 2 seconds, top speed at 250mph, and range of 620 miles. Spectacular specifications are all fully leveraged on the characteristics of lithium ion battery. This builds up the strong brand image of Tesla and conception of EV in general public's mindset. With establish reputation, subsequent products launched by Tesla are more

modest in pricing and most importantly, drastic cut in range by 50% to 300 miles and below, in order to cut down costs in the expensive battery.

Tesla: Far Sighted Technology Development Focus

Comparing to late comers in EV market, Tesla did not focus much on the technological aspect of lithium ion battery from the very beginning. It used commodity specification 18650 lithium ion battery for quick time to market of its products, lower costs and readily available supply chain, a key consideration in view of the 7,000+ units fitted in each vehicle. Of course, its visionary founder Elon Musk did invest in futuristic technologies such as autonomous driving, quick charging technologies, extending battery life, and lobbying for government subsidies, both in the USA and foreign countries.

Tesla: Good Timing to Market with Luck

It must be admitted that Tesla timed the market, social trend in green life, and the attitude of government towards EV subsidies with excellent acumens. This culminated in the launch of Model 3, which came after the Roadster, the Model S, and the Model X, that paved the way for Elon Musk's vision of a mass market. Without seeing the car, not even the final specifications, buyers rushed to make reservation for the potential car to take advantage of the expiring USA government subsidy program, with full confidence in Tesla's credentials. In the first week of release, Tesla Model 3 booked 325,000 pre-orders that amounted to USD14bn, and the flamboyant founder claimed it "the single biggest one-week launch of any product ever."

Tesla: Paving the Solid Infrastructure Foundation

Being a nascent industry, EV lacks the matured infrastructure enjoyed by its fossil fuel counterpart, such as filling stations. Yet riding on the emission reduction and green life trend advocated by the then USA President and general public, Tesla secures valuable resources and preferential policies in parking space allocation, quick charging station installation priority, reduced electricity tariff for charging, among other. May be the only exception it yet to secure is dedicated or priority traffic lane arrangement in highway.

Tesla: Focusing on Battery Capacity Rather Than Technology

While some EV players focus on developing future generation of lithium ion battery chemistry and technologies with hope to leapfrog the competition, Tesla's strategy is to leverage on current battery technology and eye on kWh production capacity to fulfil its vehicle production plan. Towards this goal, Tesla spent billions of dollars to build a large battery factory in Sparks, Nevada near Reno called Gigafactory 1. Despite the grand scale and investment involved, it is still making commodity format and specification battery, only at lower costs.

In executing these strategies, Tesla builds up a loyal customer base and good reputation of its EV.

This is in sharp contrast to other EV makers, notably the Chinese.

Chinese Players Hoping for Leapfrog in EV Chemistry

Chinese players adopt different strategies in the development of their EVs. Initially, they considered they are in level playing ground with all other players and tried to develop leapfrog technologies. Notably BYD, who develops its own lithium ion battery chemistry and put on substantial research and development efforts in hope of improving its proprietary chemistry to match leading specifications in energy density by weight and volume, quick charging time, battery life, etc.

China EV Makers' Plain Vanilla Strategy

Without the eye-ball catching sports cars to start with, the luxury sedans to follow up, and targeting the mass market from the very beginning, Chinese players keep a keen eye on cost cutting and install small kWh capacity battery in their EVs and thus short mileage range. Without the Tesla Roadster style brand building, their EVs compete head on with fossil fuel vehicles in the budget conscious China market and other similar segments. As an example, BYD's e6 comes with 87 mph top speed, 0 to 60 km/h in 7.69 seconds and 250 miles range. Some makers even offer EV with under 250km range.

Truly Leapfrogging in the Niche Taxi and Car Rental Markets

Yet Chinese EV players did find a niche. In a bid to ramp up sales quickly, they rushed to develop the taxi and car rental markets, which are not buying one, but hundreds of EVs at a time. Again, with plenty government subsidies and inherent advantage of centralized car pool for easy sharing of charging facilities, this is a viable strategy and they made initial success. As a result, BYD claimed the top spot in annual sales and cumulative sales, until 2019.

Exhibit 2: BYD Hertz Partnership in EV Rental with BYD e6

Source: byd.com

Yet Quick Success Backfired

While passing the decision of vehicles purchasing from individual drivers to taxi and car rental companies can boost sales volume quickly, it fails to build up customer loyalty and a strong brand. This strategy backfires when the battery deteriorated to the extent that driving range has shorten to make drivers worrying stop dead on the road. Though changing the entire battery pack is an easy mechanic job for EV's modular design, cost is a concern as the power battery alone typically account for 40% cost of EV. Beware that government subsidy is on EV, not on replacement battery. The whole economics collapse and the result is the EV graveyard in Jiaxing, Zhejiang, which housed 4,000 EVs previously deployed in the car sharing market, according to news reports.

Exhibit 3: EV Graveyard in Jiaxing, Zhejiang

Source: 每日经济新闻

It is yet to see an exit from this dead end.

Blue Sky Coming: NIO's Formula E

Among domestic players, one stands out and aims high. NIO, with Chinese name, Weilai, which means Blue Sky Coming, is taking the Tesla route and goes one step further. It has established the London office to build its performance program and the NIO Formula E team, and the supercar development.

Exhibit 4: NIO Formula E Race Car

Source: NIO

Following Tesla's footstep, NIO has the sports car NIO EP9 in its portfolio, which boasts one of the fastest electric cars in the world and made the 06:45.900 lap record in Nürburgring Nordschleife Germany in 2017. It has also made the new world record for the fastest self-driving car at Circuit of the Americas (COTA) in Austin, Texas with a lap time of 2 minutes 40.33 seconds and a top speed of 160 mph without a driver.

Exhibit 5: NIO EP9 Made Records

Source: NIO

Of course, NIO has other models of more moderate EV, and one futuristic concept car in its portfolio. Yet the sad news is that its war chest is drying out. Market news are circulating that NIO is seeking funds from other industry players and this may be a good opportunity for merger to grow strong and big. Let's wait and see if it survives and thrives.

Economics Aspect of SEPT Framework

We analyse the economics of EV makers in production and the EV buyers in making buying decisions and aftermarket costs, taking into account of government subsidies, a key consideration in EV industry, in this section.

From the perspective of EV makers, its subsistence relies on sales receipts after deducting costs. Sales can have a boost from government subsidies of various forms, and costs cuttings and savings are key to profitability.

Tesla: Cutting Costs in Power Battery

For EV makers, power battery is a core component and a key cost item that accounting for 40% of production cost, depending on mileage specification of the EV. Tesla excels in this area. It tackles this by using commodity 18650

and 2170 formats in its EV for fast ramp up in production and mature battery production technology. Instead, it focuses on economy of scale by building up gigantic capacities, the Gigafactory 1 in Nevada and Gigafactory 3 in Shanghai, to lower production costs.

Chinese EV Makers Betting on Long Shot Battery Chemistry

In contrast, Chinese EV makers are betting big in proprietary power battery technologies with hope of leapfrogging their overseas competitors in the EV market. Their approach is on adopting a low production costs battery chemistry. A notable example is BYD, which invests substantial efforts on the R&D of its lithium iron phosphate (LFP) chemistry. This helps initially propelled BYD into the top spot of EV market, yet backfires when the costs savings from its R&D efforts are not catching up fast enough with Tesla's economy of scale in capacity expansion. The failure to boost efficiency of LFP chemistry is hitting BYD hard, especially when government is cutting subsidies on EV and raising the bar for qualifying.

Tesla: Government Supports on Gigafactory 3

While all EV makers are jogging for government supports and subsidies, from cheap land, low interest rate loans, speedy administrative approvals and city license permits, among others, Tesla again out paces its local peers. Despite the tension in Sino-US trade dispute, Tesla made record speed in building the Gigafactory 3 in Shanghai and start delivery of first vehicle in less than a year from factory ground breaking. Moreover, it secured a RMB9bn low interest rate loan from a consortium of banks in China.

Higher Fixed Costs on Lower Variable Costs for EV

For EV buyers, it is a matter of fixed versus variable costs trade-off when comparing EV and fossil fuel vehicles. While the all-in production costs for EV is higher due to the expensive power battery, which can account for 40% of EV costs, its operating costs are lower on fewer mechanical parts to replace and repair, and more importantly, cheap fuel costs over the life of EV as electricity is cheaper than fossil fuel on per mile basis. The case is even stronger in countries where gasoline price is high, as fuel costs for EV is only 40% that of fossil fuel counterparts on per mile basis. Of course, this maths excludes the battery replacement, as it may be cheaper to buy a new EV, taking into account of subsidies in cash or other forms.

EV Infrastructure is Not Purely Economic Concern

While fossil fuel filling stations can be taken for granted, EV charging stations are still limited, especially quick charging stations that not only demand dedicated spaces, their drain on power grid is also demanding. Simple maths to see that charging up 80% capacity of a 80kWh battery pack, about 60kWh rounding, will be equivalent to 20 wall outlets working in full power for one hour, as each is delivering 3kW maximum or the fuse will blow out. Going the other way round, a wall outlet will take 20 hours to charge up the pack. It is good that with government supports and subsidies

in fitting quick charging stations, this concern is alleviating. Good EV infrastructure gives owners a peace of mind or otherwise EV will sit idle in garage for charging, an economic waste.

Huddling for Warmth: Alliances on EV Infrastructure Sharing

China EV makers are forming alliances on EV infrastructure sharing to speed up and extend their networks. Enovate, previously known as Dearcc, has signed a strategic cooperation agreement with UNIEV, an online platform service provider in the EV charging business. UNIEV was co-funded by State Grid, China Southern Power Grid, TELD and Star Charge, and has signed up over 110 charging business operators by late 2019, and has accessed to over 43,000 public charging poles in China.

Xpeng Motors and NIO Power were doing the same to collaborate on battery charging services, optimizing the charging experience for their customers. Xpeng car owners will be able to use NIO Power's supercharging piles through the Xpeng APP. NIO car owners can also use the Xpeng supercharging piles across many 1st and 2nd-tier cities in China. As a service supplier, NIO Power will also join the Xpeng home charging service system, providing Xpeng customers with charging pile home installation services.

Government Subsidies Playing Significant Roles

Government subsidies of various forms, such as cash rebates, tax rebates, interest subsidy, do lower the initial purchase costs of EV. The sad fact is that such subsidies are dwindling in major markets. In addition, such form of subsidy may be in the wrong direction. From a purely economic point of view, EV should be driven as hard as possible so as to recover the high initial fixed costs by fully utilizing the cheaper operating costs, versus their fossil fuel counterparts. Yet most forms of government subsidies focus on the initial purchase of EV, with few on the operating aspect such as lower electricity for charging, priority traffic lane allocation, etc.

Soft Issues in EV Add Up

While government subsidies on initial EV purchase is a huge lump sum, soft subsidies on EV during its operating life may seem minimal at first look yet they are substantial over years. Items such as preferential parking spaces seem free yet it is of economic value. Lower electricity tariff at night, the typical non-peak hours, is a good fit to load balancing of the electricity grid and beneficial to all stakeholders from power companies to end users. In China, administrative orders on vehicle licence issuance and entry permits to city centre are all valid measures to support EV in view of its pollutant-free emission, and these are good incentives to EV owners in making the buy decision.

Resale Value, If Any

Few car owners talk about resale value of EVs in the China market, as compared to the more mature U.S. and EU market. Yet for the more

expensive and prestigious brand EVs, resale values can be substantial. Tesla is known to have a robust used car market and high resale values. See if Tesla can educate customers and replicate its success in China.

China EVs did poorly in the resale market. BYD's e6, once featured in EV rental market with Hertz, retained about a quarter of its value after 3 years.

Exhibit 6: BYD's e6 Retained a Quarter of Value

Source: autohome.com.cn

Politics Aspect of SEPT Framework

General public's view towards green life and government's advocation and subsidies play a great role in the development of EV market. EU is the vanguard in this area and has the most concrete time table in place regarding the emission reduction of fossil fuel vehicles and its eventual phasing out.

Trump Administration is known for its profit oriented focus and disregard of environmental issues, such as green house gas emission, etc. Chinese government does not go this far, yet supports and subsidies towards EV industry are waning.

A Turn in Tide Under Trump Administration

Politics does play key roles in the development of EV industry. While the U.S. and EU are keen on going towards a green society, EV development got strong boosts with generous subsidies offered to EV buyers. EU is the

vanguard in phasing out fossil fuel vehicles. The current Trump Administration is going the other way around, as a result, EV subsidy programs are phasing out in the U.S. market.

China Government Hope Big on EV

Chinese government is hoping for a leapfrog in EV technologies to level the playing ground with developed countries and offered strong supports to local EV players. Yet the cost-conscious clientele is not helping as much as the green life conscious U.S. and EU car buyers. The Chinese government's strategy in promoting competitions among multitude of EV players did not work well and spread limited resources too thin. When various subsidy programs are tightening in the middle of 2019, EV market faced significant down turn. Yet with the boost of Tesla's presence in China and the commencement of production in its Gigafactory 3 in Shanghai in early 2020, a revival can be expected. However, the local EV players are still expected to see tough time ahead, especially the ones with weak technologies and financial resources.

MIIT White List to Exclude Foreign Battery Makers

To foster the growth of domestic players, Ministry of Industry and Information Technology (MIIT) issued in March 2015 the Standard Conditions for the Automobile Power Storage Battery Industry, and stipulated that only EVs with batteries offered by suppliers included on the white list were qualified for subsidies. But of a total of 57 enterprises involved, Japanese and Korean battery giants such as Samsung SDI, LG Chem and Panasonic have not been eligible for entering the white list. This list is finally scraped in June 2019.

China Raising the Bar in Qualifying for Subsidies

China government has also changed tack and started raising the bar on EV subsidies in order to implement its supportive policies more effectively. In its joint notice issued by four ministries in March 2019, it specifically stated to raise the requirements on technical benchmarks such as EV battery energy density, energy consumption and mileage. The focus will shift to infrastructure build up and the operations of EV, tying subsidies to actual mileage driven.

Upon implementing the notice in force in June 2019, China EV sales turned south in each month after years of good time and EV makers are facing head wind.

China Embracing Foreigners

Yet the China government is still supportive on EV industry, though this time it turns to foreigners and more importantly, it grants substantial concessions in some key issues. The Tesla Gigafactory 3 is China's first wholly foreign-owned car plant and may serve as a reflection of the government's broader shift to open up its car market toward foreign

players. While Tesla is focusing more on high and medium EV market, Nissan LEAF with 40kWh battery and 350km range will compete head on with local players in the low-end market and can be a more dangerous threat.

Soft Issues in Vogue

After years of emphasising subsidies on initial EV purchase, China government targets soft subsidies on EV during its operating life in its latest strategy. Half price on parking and electricity tariff for charging, and other none out of pocket benefits such as administrative orders on vehicle licence issuance and entry permits to city centre are in place to support EV market. The latest notice even mandated that some EVs will have to meet the requirement of 20,000km mileage in two years in order to entitle for subsidies or otherwise subsidies will be clawed back, which is a very practical measure on economic return metrics.

Technology Aspect of SEPT Framework

EV is an entirely new design with new power chain and energy system placement in the car frame, and therefore, the consideration on safety, mechanical strength, and centre of gravity, among others, are different comparing to traditional fossil fuel automobiles. Yet the most crucial part is the power battery.

Power Battery is the Key Technology in EV

There are several competing chemistries in lithium ion battery in EV and each chemistry comes with its own merits and short comings. The most important metric is energy density, measured in kWh/kg and kWh/litre. This dictates the weight and space occupied by battery in EV and the mileage range. Discharging and charging characteristics dictate the horsepower and charging time needed, as well as battery life. Yet these are all subject to safety constraint, as lithium ion battery is notorious for self ignition and run away fire. So the choice of chemistry and developing the corresponding control circuits are key to safety and operation of EVs.

Tesla Picking Quick EV Battery Solution

Tesla chooses to use commodity 18650 and its cousin 2170 developed by Panasonic in its EV. With its small form factor, Tesla fitted 7,000+ of these thumb size batteries into its Model S. Being a front runner, Tesla have no readily available dedicated EV battery on hand, so it goes the other way in developing sophisticated battery management technology. And it succeeds in integrating these 7,000+ small cells to deliver the power required for sports car style EV it offered and quick charging mechanism with its proprietary charging stations. Together with its Gigafactory's superb

production technology, Tesla churns out tens of GWh battery to fit its booming EV sales.

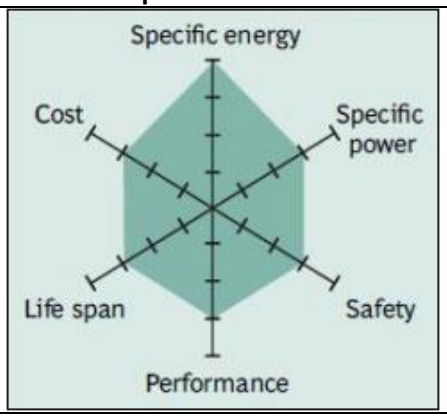
Battery Power Management System at Works

Tesla is famous for hardly lose any capacity over the life of its battery. By having so many cylindrical cells working together, each is only taxed slightly during discharge, and prolong the useful life of each. This is in sharp contrast to the system consisting of a small number of large kWh capacity batteries, with heavy draining of power even on cruising speed driving and the battery can burn out in as short as three years. Also, Tesla's cylindrical batteries have little volume and plenty of surface area and spaces in between for good cooling, during both discharge and charging.

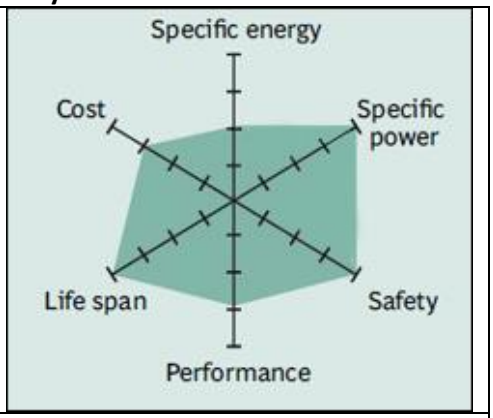
China Betting on LFP Chemistry

Chinese government has heavily subsidized LFP batteries, for electric buses as well as electric cars. Contemporary Amperex Technology (CATL) and BYD are key players in this chemistry and has made substantial progress in boosting its energy density while enjoying the low production costs of LFP versus other chemistries. Yet LFP batteries come typically with lower energy density than other chemistries. CATL's LFP batteries are said to be 160Wh/kg, while Tesla's NMC 2170 cells made by Panasonic are 247Wh/kg. This may partially explain why lots of small battery capacity, short mileage range EVs in China market. The inherent higher self-discharge rate of LFP chemistry exacerbates the problem.

Exhibit 7: Snapshot of NMC and LFP Chemistry



Snapshot of NMC, Lithium Nickel Manganese Cobalt Oxide ($LiNiMnCoO_2$)



Snapshot of LFP, Lithium Iron Phosphate ($LiFePO_4$)

Source: batteryuniversity.com

Trying Dual Chemistries

China government's stance towards the mileage range of EV are changing and favour to promote longer range and thus may see a shift in the Chinese market away from pure play LFP chemistry.

CATL is offering NCM chemistry for electric passenger vehicles and LFP for buses, which may be able to balance the high costs of NCM and low density of LFP. There are market news circulating that Tesla is considering to adopt LFP batteries in its 100kWh version of Model 3 in order to control costs. Yet the flip side is to R&D on two chemistries, both for the battery makers and the EV makers.

Hydrogen Fuel Cell Vehicle (FCEV) to Join the Fray

Another big category of EV is that powered by hydrogen fuel cell, rather than by lithium ion battery. Hydrogen fuel cell technology has been available for a long time yet the expensive cell stacks and lack of hydrogen fuelling stations, among others, restrict its deployment. It works by the chemical reaction of hydrogen in fuel tank and oxygen in air and directly generate electricity to drive the motor. So no burning at all and the only exhaust is water.

Quite some hydrogen fuel cell research vehicles are around, but few commercial ones are available. The hottest news is that the 2020 Toyota Mirai is scheduled for launch in late 2020, initially in Japan, North America and Europe markets. Its full specification is not published yet. But looking back at its earlier model with 153hp and acceleration from 0 to 60mph in 9.0 seconds, it is targeting the mass market, though the new one is tipped to go up the ladder. With severe lack of hydrogen filling infrastructure in place, FCEV is yet to challenge the lithium ion battery EV in the near future.

Conclusion: Last Stand in Long Mileage LFP Chemistry

With raised bar to qualify for reduced subsidies, China EV makers are going thru tough time ahead. The bright side is that China government has put in more tactical considerations in additional to purely strategic ones and align its policies with free market economics.

While green society is still a key foundation stone to EV market and educating the general public on the long term benefits of green life should be a on-going task, China EV makers should have a broader sense to line up with their more successful foreign counterparts in offering consumer friendly products in the still costs conscious China market. Placing too much consideration in costs and offering EVs of unrealistically short range, too short battery life, too few charging cycles, they are now facing the backfires.

While EV makers should on one hand continue their efforts in soliciting government subsidies, from big ticket items such as cheap land, favourable tax treatments, and low interest rate loans in building new plants, to small ones such as subsidized parking spaces and electricity tariff, they should also revamp their product offerings to meet the needs of drivers.

Consolidations among EV makers are inevitable in a market with too many small players. Yet the key point, in our view, will be for the larger ones to carve out their respective territories, both geographically and product wise. Tesla may have taken Shanghai for now. Others may target Guangzhou, Shenzhen, and other major areas, and work to obtain similar terms with provincial and city governments. Infrastructure for EVs are still insufficient and by building up sophisticated infrastructure in several key cities, EV makers can fence their turf and demonstrate to drivers that it is hassle free in driving an EV.

Busy building a presence in all cities over China has shown its limitations and it is time to focus in few major ones to demonstrate the viability of EV in social and economics sense. R&D in technology for excellence is a must for the still nascent EV industry and advancement in technology go hand in hand with product development.

One key area for China EV makers to develop and defend to last stand is the long mileage segment deploying LFP chemistry. The logic is simple: they have seen the dead end on short range, the inherent deficiency of LFP chemistry, and they should have visualized the potentials in combining the cheaper manufacturing costs of LFP chemistry and long mileage EV. Moreover, news is circulating that Tesla is going that direction. If Tesla succeeds in this segment before China EV makers do, what is left to China EV makers will be nothing.

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