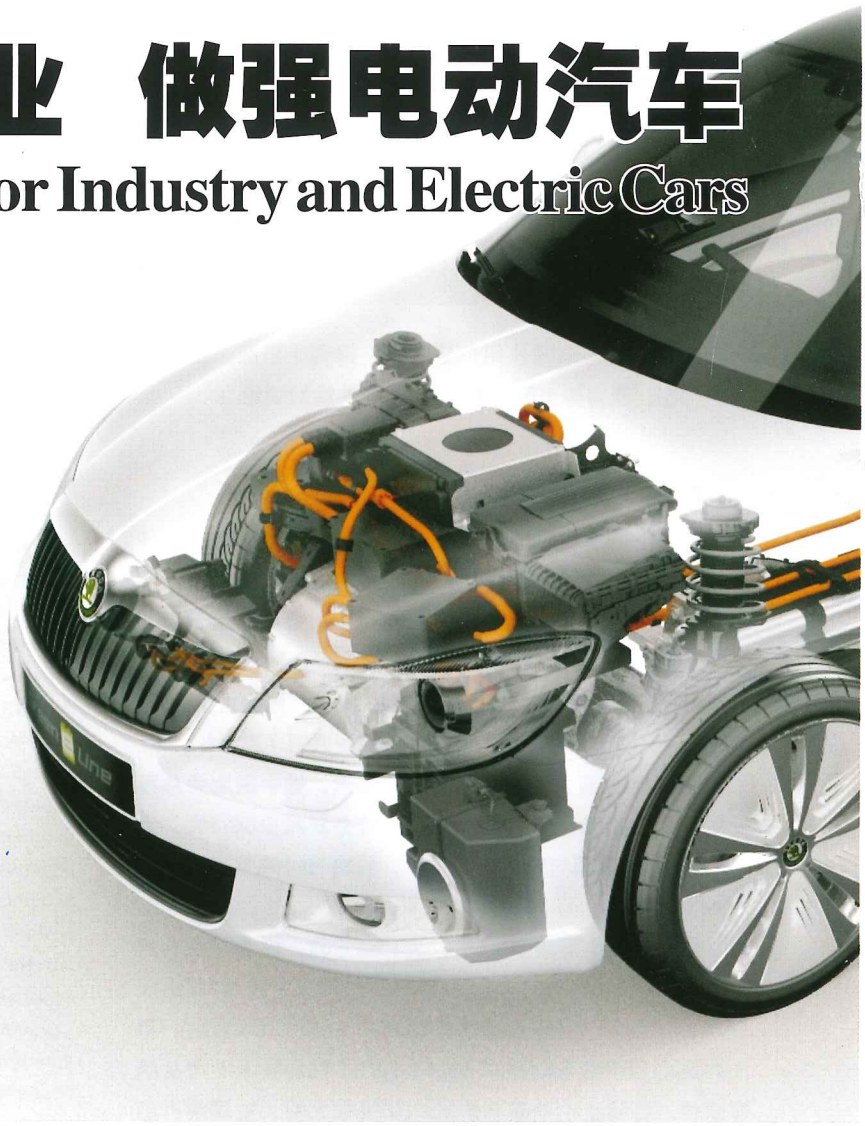
发展电机产业 做强电动汽车

Development of Motor Industry and Electric Cars



国家规定的油耗标准,到2020年要求乘用车企业平均油耗要达到每百公里5.0L。企业不做节能与电动车,这个标准是不可能达到的。做电动车的三大技术：电池,电机,电控都是不可或缺的。必须发展电机产业,才能做强电动汽车。

长远战略发展纯电动车

电动车产业化，率先做起来的是客车，其次是小轿车，估计年内会有一些有竞争力的小车出来。

我国有三个领域比较适合发展电动车：一是商用车，以客车为代表，客车的产销规模全球最大；二是小车，我国自主品牌小轿车都集中在A或A0级以下；三是专用车,比如环卫、物流、公务用车等。

电动汽车包括纯电动车、燃料电池车、插电式混合动

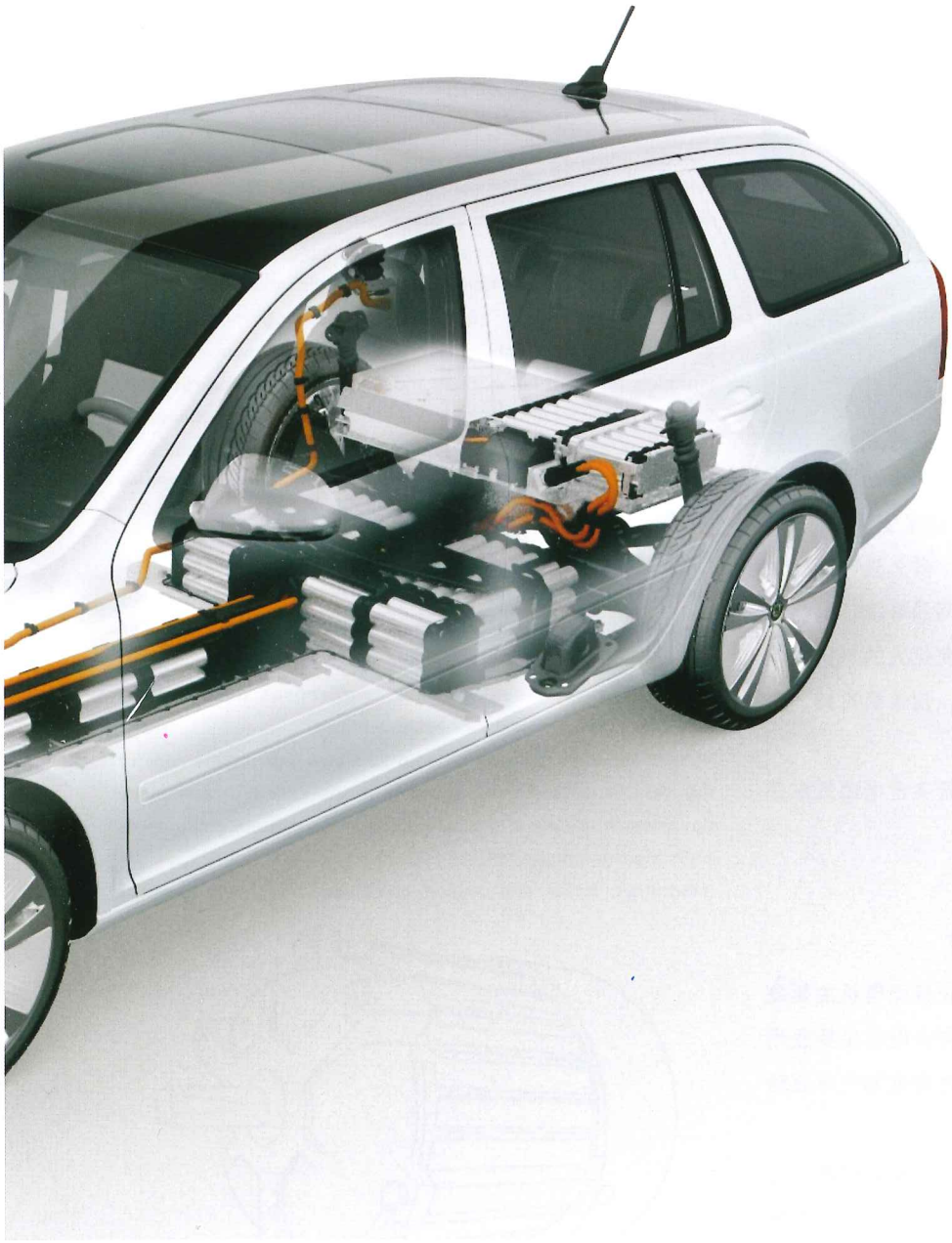
Fuel consumption criteria stipulated by the state is that, to 2020, passenger cars should reach the average fuel up to 5.0 L per hundred kilometers. If companies do not turn to the energy saving and electric vehicles, the goal can not be obtained. Three technologies: electric battery, motor, electric control in the electric car are necessary. The motor industry should be developed to strengthen electric cars.

Long-term strategy to develop pure electric vehicles

In the industrialization of electric vehicles, the first is the passenger bus, then the sedan. In this year, other small cars will emerge.

China has three areas more suitable for development of electric cars. The first is the commercial vehicle which is represented by the passenger bus. The passenger has the world's largest production scale. The second is the small car in which China is predominated by brands A or A0 or below. The third is the special car, including in sanitation, logistics, office and etc.

Electric cars include pure electric vehicles, fuel cell vehicles, plug-in hybrids and range-extended electric vehicles. Non-plug-in



文/ 莎丁丁 Text/Sha Tintin

力车以及增程式电动车。非插电式的都归为节能汽车类。插电式混动车与增程式电动车有所不同，插电式混动车以燃油为主，电力为辅，纯电模式行驶20-60公里；增程式电动车纯电模式行驶50-80公里，以电力为主，燃油为辅。

我国长远的战略还是发展纯电动车。现在能源安全、环境保护、行走安全、汽车动力转型升级等等问题都比以前紧迫，政府现在推广电动汽车的态度比以往更加坚决。

车用工况约束驱动电机系统

汽车是一种特殊的产品，尤其是家用轿车，它的空间寸土寸金，电机需要高密度、小型化、轻量化，电动车驱动电机需要高效率、高适应性。

低速高转矩和高速恒功率的宽调速。在车辆起步和行

electric cars belong to energy-saving motor vehicles. Plug-in hybrid electric vehicles are different from range-extended electric cars in which the plug-in hybrid cars mainly use oil and supplementarily use electricity and under the pure electric mode they can run 20 to 60 km. Range-extended electric cars under the pure electric mode can run 50-80 km in which priority is given to electricity.

China's long-term strategy is to develop pure electric vehicles. Now the problems as to energy security, environmental protection, car power transformation and upgrading, and so on are more urgent than before. The government is more definitive than before as to the attitude to promote electric vehicles.

Motor system is restricted

Automobile is a special kind of product, especially a family car. In it, the space is very important, since it is required to be highly dense, smaller and lightweight. The motor should be highly efficient and adaptable.

Low speed high torque and constant power plus high speed. When the vehicle starts and runs, it requires a high torque. At high speed

车时要求高转矩，高速运行时能够进行恒功率输出；电机的基速和最高转速差别很大，需要很宽的调速范围。

车用工况恶劣对驱动电机的可靠性、耐久性、适应性要求很高。由于车辆振动及发动机室的高温环境，电机运行在振动大、冲击大、灰尘多、温湿度变化大的恶劣环境下。车用电机必须适应环境条件的要求，使电机可靠、稳定、安全运行。

低噪声与低成本。电机成本的高低是决定电动汽车是否能够产业化的重要因素之一。

电机主要类型及三大技术

电机分为直流电机和交流电机，现在直流电机主要是用在一些低速电动车上。交流电机里的异步电机主要是用作电动客车牵引电机，永磁同步电机是目前电动汽车驱动电机的主流路线。

车用工况很恶劣，所以对车用驱动电机要求很高，这就导致车用电机系统的三大技术发展趋势：集成化、永磁化、数字化。

集成化：电机与发动机总成，电机与变速箱的总成。混动和插电式混动的乘用车，电机和变速箱则完全一体化；这块客车的要求不太一样，客车的要求低于轿车。

永磁化：永磁电机功率密度和转矩密度高，具有效率高、功率因数高、可靠性高和便于维护的优点。采用矢量控制的驱动控制系统实现宽广的调速范围。

数字化：控制系统的数字化是电驱动技术发展的必然趋势。控制器方面主要是指电力电子总成。控制器的集成度越来越高，我们跟国外的区别主要是体积，国内一般是用IGBT模块去做集成。

电机研制现状及发展

runtime, it can be at the constant power output. There is a large difference between the basic speed and the highest speed, and it is necessary to have a wide speed range to adjust.

The working condition being poor has high requirements as to reliability, durability, adaptability of driving motors. Poor conditions include high temperature of engine room, vehicular vibration, motor vibration, dust, and high humidity change so forth. Vehicle motor must adapt to the requirement of environmental conditions, so that it can be reliable, stable and safe in operation.

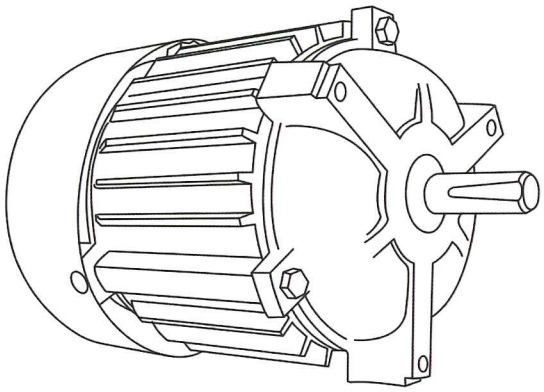
Low noise and low cost. Motor cost is one of the important factors that determine whether electric cars can be industrialized.

Main types and three technologies

Motor can be divided into dc and ac motor. The dc motor is mainly used now in some electric vehicles at low speed. AC induction motor is mainly used as a traction motor in electric passenger buses. The permanent magnet synchronous motor is the mainstream driving motor of electric vehicles.

Vehicle condition being very bad proposes a high requirement for the vehicle drive motor, and this leads to three technology development trends in the automotive motor system: integration, permanent magnetization, digitalization.

Integration: Motor and engine combined, and motor-gearbox



combined. In the hybrid and plug-in hybrid passenger cars, motors and gearboxes are fully integrate. In this regard, the passenger car is different in requirements which are lower than sedans.

Permanent magnetization: Permanent magnet motor's power density and torque density are high. Advantages include high efficiency, high power factor, high reliability and easy to maintain. Using the vector control drive control system can achieve a wide speed range for adjustment.

Digitalization: Digitalization in the control system is the inevitable developing trend for electric drive technology. The controller mainly refers to the power electronic assembly. The integration of the controller is higher and higher. The difference between our country and foreign ones mainly is in the volume. China's makers uses IGBT module in integration.

Motor development present situation and development

The technical index of the drive basically has no gap when

技术层面与国外比较,驱动电机的技术指标已经与国际水平差不多。电机的功率密度可达2.68KW/KG，电机系统高效区进一步拓宽，系统的最高效率达94%以上。

但技术方面仍面临挑战。可靠性和环境适应性考核还有不足。而且DC/AC和DC/DC电力电子总成的体积偏大。专业工艺和制造工艺技术还有待提高。

关键的电力电子元器件专用加工设备、测试设备、关键生产设备及仪器以进口为主，成本占到控制器近一半，目前已有企业开始研制并试用。上游产业链尚未完全形成，品质还没完全达到汽车工业的需求。

电机行业需要加强的技术

当前,电机行业需要重点加强的技术有以下几方面：

一是共性模块化关键技术，降低行业的研发成本；二是加强机电耦合设计和一体化集成，提高整车适应性；三是加强关键共性技术研究，建立有效的技术指标和评价体系；四是加强可靠性、耐久性和环境适应性技术研究及应用；五是结合国家重大专项，开发关键装备。

做好电机才能做好电动车这是不争的事实。特斯拉是一款很炫的车，有一点比较抢眼：百公里加速只四秒。加速时间就与电机功率相关。国内电动汽车电机一般是50KW以下，特斯拉大约为200KW左右，把功率提上去加速当然很快。做好电机,做强电车。

compared with foreign countries. Power density of the motor can reach 2.68 KW/KG. The high efficient area further broadens for the motor system. The system's highest efficiency is more than 94%. But technology still faces challenges. Reliability and environmental adaptability evaluation is not yet sufficient. And DC/AC and DC/DC power electronic assemblies are large in volume. Manufacturing process technology needs to be improved. Key electrical and electronic components' processing equipment, testing equipment, and key production equipment and instrument depend on imports. The cost accounts for almost half of the controller. At present, there are companies begin to develop them. The upstream industry chain has not yet fully formed. The quality hasn't completely satisfied the requirement of the automobile industry.

Motor industry's technology to improve

Current, motor industry needs to focus on strengthening the following technologies:

First is universal modular technology for reduction of industry research and development costs. Second is to strengthen mechanical and electrical coupling design and integration so as to improve the vehicle performance. Third is to strengthen the universal technology research and establish effective technical indicators and evaluation systems. Fourth is to strengthen the research and application for the reliability, durability and environmental adaptability tech. Fifth is to combine national major projects to develop key equipment.

That the motor is very important to electric cars is indisputable. Tesla car is very attractive: hundreds of kilometers acceleration only four seconds. Accelerating time is related to the motor power. Domestic electric car motor is usually below 50KW, while Tesla is about 200 KW. When the power is high, then acceleration will be quick. The better the motor, the better the electric vehicle.

特斯拉旋风刮到中国
Tesla Comes to China

文 / 董小靳 Text /Dong Xiaojin

纯电动汽车品牌特斯拉正式进入中国形成一股旋风,特斯拉在官网高调公布ModelS车型在华定价--73.4万元人民币，并把定价计算公式晒出，远低于业内原先估计的高于100万元人民币。

2013年5月28日，特斯拉宣布已经偿清美国能源部贷款，并将推进充电网络扩张，特斯拉的名字突然爆红,在纳斯达克的股票价格突破100美元大关，至110.33美元。特斯拉2013年第四季度财报，远远好于市场预期，2014年2月19日,股价创下224美元的历史新高。

优越的性能体验、高度的性价比，让特斯拉成为2013年最时髦的电动汽车品牌，被誉为汽车界的苹果公司。曾经由于电池技术限制，电动汽车无法完全替代燃油汽车，特斯拉似乎找到一条与市场对接的路径。

车性能打动人心

在2013年特斯拉汽车公司发布第一季度财报后，特斯

Tesla as a pure electric car brand officially enters China as a tornado. Tesla announced on the official website that its ModelS was priced at 734000 yuan in China, and showed the pricing formula. This is far lower than the expected price being over 1 million yuan.

May 28, 2013, Tesla announced it had fully repaid loans by the U.S. department of energy, and it would boost the charging network expansion. Tesla rapidly attracted attention. In NASDAQ, its stock price was over the $100 mark and rose to $110.33. Tesla's earnings in the fourth quarter of 2013 were much better than market expectations. February 19, 2014, Its stock price hit a new record of $224.

Superior performance experience and high performance-cost ratio enable Tesla to become the most fashionable as an electric car brand in 2013. It has been hailed as the Apple in the car industry. In the past, the battery technology was limited, so the electric car couldn't completely replace fuel vehicles. It is likely that Tesla finds a technical road that is environmentally friendly.

EV performance

After the release of Tesla' s first-quarter financial report in 2013 earnings, its electric cars were given 99 points in evaluation by the authoritative magazine - Consumer Report. Different from common electric cars in the market, its products are high technical and well balanced between the energy industry and the IT industry. Popular model

拉电动汽车就获美国权威杂志《消费者报告》99分的评价，满分为100分。与市场中常见的电动汽车不同，特斯拉具有强科技属性，在能源産业和IT産业之间做到了完美的平衡。广受好评的车型Model S车内配备了一个17英寸的触摸屏以及2个USB插口。据《消费者报告》，驾驶这个车辆"就像使用iPad一样"。

价格居高难下，不靠政府补贴很难获得市场效应一直是电动汽车的致命弱点。特斯拉在这方面取得突破性成绩。在北美，特斯拉Model S定价约7万美元，购买者还可以获得大约1万美元的退税，实际上是6万美元，也就是38万元人民币。国内唯一成熟的新能源车比亚迪E6售价约37万元，价格几乎与之相当。

但是，在配置方面，Model S百公里加速仅为4.4秒，比亚迪E6为10秒以上；Model S的最大马力422，E6的最大马力为122；Model S的峰值扭矩为600牛顿.米，E6则为450牛顿.米。同样的价格下，性能却是天壤之别，特斯拉爆红完全是凭实力说话，并非营销伎俩。

对于性能的不断追求是特斯拉成功所在。它是世界上第一款使用锂电池一次充电可行驶350公里以上的纯电动车。2009年，该跑车创下一次充电行驶501公里的世界纪录。它的提速能力在电动车中也领先，从静止至100公里/小时仅需约4.4秒钟。

2013年，特斯拉公司交付了2.2477万辆汽车，预计

– Model S car is equipped with a 17–inch touch screen and 2 USB ports. According to Consumer Report, driving this vehicle likes the use of iPad.

Prices are a problem. Without government subsidies, electric cars are difficult to obtain market effects, which is Achilles' heel. Tesla achieves a breakthrough in this respect. In North America, Tesla Model S is priced around $70000, and buyers can get about $10000 in tax rebates. So, it price is actually $60000 or 380000 RMB yuan. In China, the exclusively mature new energy car – E6 is priced at about 370000 RMB yuan. This price is comparable to that of Model S.

However, in terms of configuration, Model S is only 4.4s per 100 kilometers in acceleration, E6 10s; Model S is 422 in max power, E6 122; Model S is 600 N.m in peak torque, and E6 450. Under the similar price, the difference is large in performance. Therefore, Model S has superior performance setting off a storm in the market.

The constant pursuit of better performance leads to Tesla's success. Its car can drive more than 350km as the first pure electric car in the world after a charge to lithium battery. In 2009, its sports car broke the world record of driving 501 km after a charge to the battery. Its acceleration from static state to 100km/h is just about 4.4 seconds.

In 2013, Tesla delivered 22477 cars, and is expected to deliver more than 35000 car in 2014, that is, its sale growth will be around 55%. In the first quarter of 2014, the Model S output will reach 7400 units. In the first half of 2014, the battery problem will continue to limit electric car production, but in the second half, the problem will be improved significantly. Tesla currently hold total cash that grows to $846 million.

Tesla's first Model S cars are ready for China. Now, Beijing becomes the largest and most active retail location in the world.

Tesla's founder and CEO Musk said, "For many years, almost all people think electric car production is a stupid and crazy task. It may be the most stupid decision to enter the electric vehicle market." But now, Tesla has harvested a batch of star users, becoming one of the most eagerly awaited technology companies.

Battery technology is rather special

2014年将增加至3.5万辆以上，即销售增幅达到55%左右。2014年第一季度，Model S的汽车口量将达7400辆。2014年上半年，电池供应问题还将持续对电动车生口量造成限制，下半年该问题将有显著改善。特斯拉公司目前所持有的现金总量增长至8.46亿美元。

特斯拉首批对中国发售的Model S汽车已经到位，现在北京已经成为其全球最大、最活跃的零售点之一。

特斯拉创始人兼CEO Musk曾表示："很多年以来，几乎所有人都认为生口电动汽车是一个愚蠢而又疯狂的工作，进入电动汽车市场也确实可能是一个人能够做出的最愚蠢的决定。"但是如今，特斯拉已经收获了一批明星用户，并成为最受期待的科技公司。

电池技术颇为特殊

特斯拉的明星车型Model S是2013年的北美豪华车销量冠军，这是电池技术不懈追求和突破取得的成绩。

为了让电动汽车更实用，特斯拉正在拼命缩短充电时间。充满电池的时间已经缩短到与加满一箱油的时间差不多了。特斯拉能实现如此短的充电时间，靠的是特斯拉高出一般电动车电池储能3倍的电池组及特殊的电池管理系统。

特斯拉是目前唯一采用18650型钴酸锂离子电池的汽车公司，这种电池曾被认为技术老旧，难登大雅之堂。早在20世纪70年代，英国宾汉顿大学的Whittingham女士就发明了18650电池。这种电池常应用于笔记型计算机、强光手电等数码產品上，但是将这种直径18毫米、高65毫米的圆柱形锂电池用在汽车上，特斯拉是第一个吃螃蟹的人。

特斯拉起初尝试了市面上超过300种的电池，包括板形和方形电池，最终选择了松下的18650型钴酸锂离子电池. 原因是：能量密度大且稳定性、一致性好；可以有效降低电池系统成本；生產规模大，安全级别不断提高；尺寸小但可控性高，即使电池组的某个单元发生故障，也能降低故障带来的影响。

从Roadster到Model S车型转变的4年时间，电池组成本已经下降了约44%，并且仍在继续下降。

18650电池安全系数较低，热特性和电特性较差是不争的事实，特斯拉的解决方法是把几千节2安时18650封装电池通过串联和并联结合在一起。驱动一辆电动车需要大量电能，特斯拉 Roadster的电池系统包含6831节小电池，

Tesla's star model – Model S is a champion of 2013 in North American in sales of luxury cars. This success is due to the unremitting purse of battery tech and its breakthrough.

In order to make electric cars more practical, Tesla strives to shorten the charging time. The time to fully charge the battery is shortened to the extent at which it is similar to fueling time. This success is due to its battery pack and special battery management system. Capacity of this battery is 3–fold that in the traditional EV battery.

Tesla is currently the only car maker using 18650 type cobalt acid lithium ion battery. This battery technology previously was considered as old and not appeal. In the early 1970s, Ms. Whittingham invented 18650 battery. It was often used in notebook computers, and other digital products. This battery that is 18 mm in diameter and 65 mm in height and cylindrical in shape is used in the electric car by Tesla for the first time.

At first, Tesla had a trial use with more than 300 kinds of batteries on the market, including flat and square batteries. Finally, it chooses 18650 cobalt acid lithium ion battery from Panasonic. The reason is

Model S更是高达8000节，排列组装这些数量众多的小电池就成为其中的关键。

特斯拉把网络控制领域用程序控制成百上万台服务器的模式搬到了电池系统的控制上，通过一年的实验设计，用分层次管理的办法成功控制了近万节小电池以及电压和温度。

69个18650电池被并联封装成一个电池砖，99个电池砖串联成一个电池片，11个电池片组成一个电池包。仅仅有这些层次还不够，每一个层次都要进行监控，在每个电池单元、每个电池砖、每个电池片的两端均设置有保险丝，一旦电池过热或者电流过大则立刻融断，断开输出。

在每个电池片上，均设置有BMB (Battery Monitor board，电池监控板)，监控每个电池砖的电压、温度以及整个电池片的输出电压；在整个电池包上，设置有BSM (Battery System Monitor，电池监控系统)，监控电流、电压、温度、湿度、方位、烟雾等整个环境；在整车层面，设置有VSM (Vehicle System Monitor，车辆系统监视器)，用以监控BSM。

这样一套电池控制系统成为特斯拉的核心技术。当特斯拉首次公布这套造价高昂的系统时，几乎成为笑柄，业内认为将近1万个小电池放在汽车里的行为简直愚不可及。但事实却给予了有力的回应，雪佛兰Volt起火，Fisker Karma一年内发生3次自燃事件，而反观特斯拉，不论是Roadster还是Model S，都从未发生过起火自燃事件。

that this battery has the following advantages: high and stabel energy density, good consistency, low cost in battery system, large production size, high safety, small size, and good control. Even one unit in the battery pack fails, the impact from this can be reduced.

It takes 4 year to change from Roadster Model to Model S. During this period, the battery pack cost has dropped by about 44%, and continues to decline.

18650 battery is low in safety coefficient and poor in thermal and electrical properties. The solution in Tesla is to connect many 18650 type batteries in series and parallel. Driving a car electric car needs a lot of energy. In a Tesla Roadster car, the battery system contains 6831 small cells, and in Model S, 8000. How to arrange these cells is a key.

Tesla uses the network control program in the battery system. After the experiment and design for 1 year, the hierarchical management method is successful in controlling the voltage and temperature of these small cells.

69 type 18650 batteries are connected in parallel into a brick, 99 bricks connected in series into a sheet, 11 sheets packaged into a battery pack. Moreover, each level should be monitored. Each battery unit, each brick, and each sheet should be equipped with a fuse, respectively. Once battery is too hot or current is too large, the fuse will break at once leading to the disconnected output.

In each battery sheet, a battery monitoring board is equipped to monitor the voltage and temperature in each battery brick and the output voltage in the entire battery sheet. In the entire battery pack, a battery system monitor is equipped to monitor the entire environment, including current, voltage, temperature, humidity, direction, smoke and so forth. In the vehicle, a vehicle system monitor is equipped to monitor the BSM.

Such a battery control system is Tesla's core technology. When Tesla first announced this set of system being expensive, it almost became a laughing stock. Some people from the industry believed that it was very stupid that about 10000 small batteries were placed in a car. But the fact gave a strong response. Chevrolet Volt caught a fire and Fisker Karma caught a fire for three times in a year. In contrast, whether in Roadster or Model S, no fire occurred.