



# Electric Vehicle Revolution and Implications: Ion Battery and Energy

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## Abstract

As record high heat waves sweep globally, global warming (caused by environmental pollution and greenhouse gas emissions) has turned into the primary concern, which put the non-renewable petrochemical energy and fuel vehicles on the chopping block. The development of new energy electric vehicles (EVs) leading by USA, EU and China has the potential to achieve zero-emissions. The innovation technologies of the corresponding rechargeable ion battery play the keys role. Thus, the EVs have profound impact on traditional energy, vehicles industries and the daily life.

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## 1. Introduction

### 1.1 Development of Electric Vehicle Industry

In 2022, the record heat waves swept Europe, China, USA, India and other part of the world, followed by deadly wildfires. USA had the hottest June in 127 years with over 1503 places hit the record high; India had over 10 cities recorded 45 °C in April; the riverbeds exposed due to drought such as the Thames in England, the Loire in France, the Po in Italy and so on. However, 2022 is not over yet.

As the issue of energy and environmental crisis becoming more and more prominent, electric vehicles (EVs) have developed exponentially in the past few years. Lots of

countries resolve to the EV industry to solve the energy crisis, reduce CO<sub>2</sub> emissions and expecting to slow down the global warming, such as USA, Japan, European Union and China. They have successfully developed EVs as a national level strategy and issued a series of relevant policies to promote the research, development and sales of EVs. June 2020, the International Energy Agency (IEA) released EV sales data for 2019, which indicating that more than 2.1 million EVs were sold globally and record high 7.2 million EVs were on the market. Meanwhile, EV sales accounted for 2.6% of global vehicle sales and about 1% of global vehicle inventories with 40% increase from previous year.<sup>[1]</sup>

The global sales of EVs began to rise from 2013 (with the most significant increase in 2017 and 2018) according to a sales report for the global EV market by Deloitte on July 28, 2020, which indicating a positive attitude towards the entire EV market's prospects.<sup>[2]</sup> Thus, major automobile enterprises are gradually transforming towards EVs. In March 2021, Audi announced the termination to develop new internal combustion engines, and only increase the investment and research on electric engines and new vehicle fuel cells. Meanwhile, other traditional car companies have also started to increase their investment in these the renewable technologies.

### 1.2 Overview of electric vehicle development in China and the United States

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China, with rapid development in the field of EVs in recent years, has a promising prospect in the EV market. The auto industry for China has grown rapidly over the past two decades and now is the largest auto market in the world. October 24, 2020, National Bureau of Statistics of China (NBSPRC) released the 2019 Statistical Communique on National Economic and Social Development. According to the report, the sales volume of light vehicles in 2019 exceeded 24.8 million units, accounting for 28% of global sales.<sup>[3]</sup> Deloitte predicts that it will increase to 49% of the global EV market by 2030, 27% for Europe and 14% for the USA.<sup>[2]</sup>

China has removed the less than 50% restriction of foreign ownership for the joint ventures, which will allow more domestic and foreign companies to invest in the EV. Meanwhile, the EV industry is also being closely monitored by regulations, which subsidize research and development units of local EV companies while preventing over-investment.<sup>[4]</sup> On the other hand, they also encouraged the development of New Energy Vehicles (NEVs) based on battery technologies and other non-combustion technologies such as fuel cells (FCs) and improving battery performance lifetimes.<sup>[5]</sup> Thus, a new automobile ecosystem will be established by encourage the innovation in EVs and autonomous driving.

Meanwhile, EV companies in USA have long been ready to go globally. The USA is one of the earliest countries in the world to develop EVs. In 1834, the world's first electric car was born in the USA. Since then, the USA has never stopped exploring EVs, paying more attention to environmental protection, energy conservation, emission reduction, and developing environment-friendly cars. As a leading state, the USA government has successfully introduced relevant policies and industry standards to vigorously promote the EV development and market environment. As the most widely known technology company, Tesla sold 509,737 EVs in 2020 according to its sales report in 2020. Such tremendous productivity is closely related to Tesla's manufacturing plant's early layout, which entered Shanghai and established a Giga factory on April 22, 2021.<sup>[6]</sup>

As car efficiency standards continue to improve, EVs will further squeeze traditional fuel vehicles' market in the future. In 2015, the LPK (liters per km, as the MPG in the USA) for passenger cars in China is 6.9 and it dropped to 5.0 in 2020. Even though less fuel has been consumed per km, the annual increase of vehicles in China and worldwide is increasing dramatically. Traditional fuel vehicles not only lead to an increasing demand for fossil energy but also cause a huge burden to the environment, which account for 60% emission and air pollutants.<sup>[7]</sup> Therefore, the development of EVs is the

need of the times and the consensus for the global tension caused by oil prices.

China, Europe and USA are the major EV markets and the development is fast in these regions. The market volume in the other part of the world is very small.

### 1.3 Pros and cons

In EVs, the electric motor converts the electrical energy into mechanical energy, which operates the wheels and working devices through the gearing. Fuel vehicles require a petrol-powered car's cooling circuits, shifting gears, clutches and more, which leads to high maintenance costs, as comparing in [Table 1](#).

**Table 1.** Advantages and disadvantages for EV and fuel vehicles.

Items	Electric vehicles	Fuel vehicles
CO <sub>2</sub>	no	yes
NO <sub>2</sub>	no	yes
Cooling circuits	no	yes
Shifting gears	no	yes
Maintenance	low	high
Time for charge/add fuel	high	Low
Driving range	low	high

On the other hand, EVs also face several major challenges related to batteries, such as driving range, charging time and weight. The range for Tesla-3 is 260-400 miles depending on model, comparing with over 450 miles for fuel vehicles. Plus, there are way more gas stations for fuel vehicles than charging poles for EVs. The range issue should be solved soon considering the fast advancing of the ion battery technologies, which should surpass the range of fuel vehicles in the next few years. Usually, it takes 4-8 hours to fully charged battery pack, and even a "quick charge" to 80% capacity takes 30 minutes. A Tesla supercharger, for example, can charge a Model S to 50% in 20 minutes or 80% in half an hour.<sup>[8]</sup> Battery packs take up a considerable amount of space in the vehicle, and the battery's weight varies depending on the capacity of the battery. The current EV battery weight is around 200 kilograms.<sup>[9]</sup>

EV battery modules are made up of thousands of small cells that work in the same way as cell phones. From a mathematical point of view, this design can improve the fault tolerance of the battery module. The range is related to battery storage capacity measured by energy density. New battery technologies address to increase the capacity without adding extra weight. The maximum range of Tesla Model S has reached 500 km.<sup>[8]</sup>

In this paper, the development of new energy EVs and batteries in China, the USA and other part of world are summarized. Then, the impact of EVs on traditional industry

and the autonomous driving in future are analyzed. Furthermore, the future for EV industry is further discussed.

## 2. Development status of electric vehicles in USA and China

### 2.1 Analysis of the USA EV industry

As the largest oil consumer and producer in the world, the USA has led to a revolution in shale gas and oil due to the combination of vertical drilling and hydraulic fracturing. Thus, USA overtook Saudi Arabia and Russia to become the world largest producer in 2018 according to the annual report from British Petroleum (BP). In 2019, oil import is U.S fell to around 9.14 million barrels per day and the export rose to around 8.47 million barrels per day according to the US Energy Information Administration (EIA). The USA is less dependent on crude oil imports than China. The consumption of fossil energy has been increased exponentially since the 21st century. Half of the discovered reserves for crude oil have been consumed, from which 85% have been consumed in the last 60 years. As the energy crisis increasing, the development of new energy vehicles is imperative.

The USA has been the major emitter of carbon dioxide (CO<sub>2</sub>) in the world since 1990. Due to the environmental protection and global warming, USA urgently needs to accelerate the development of new energy automobile industry, in order to reduce the consumption of fossil fuels and greenhouse gas emissions. Kenneth S. Kurani described this concept in his article as: "Establishing an open and efficient EV market dominated by people's livelihood, with optimized allocation of resources, striving to meet people's realistic demands for controlling air pollution and improving the ecological environment of human habitation, and comprehensively improving environmental quality".<sup>[10]</sup>

Even though the vehicle sales in USA were impacted by the COVID-19 pandemic in 2020, however, the overall market in 2021 was much better than expectation. More than 82% of consumer said their demand for cars had remained the same or even increased despite the pandemic in 2020.<sup>[11]</sup> EVs accounted for a record high of 1.8% of new vehicle registrations in the USA in 2020 according to a survey from IHS Markit. Furthermore, EV registrations in USA reached a new monthly high of 2.5% in December 2020, in which Tesla accounted for nearly 80%. The growth of market share for Tesla-S EVs from 2013 to 2019 can be seen in Fig. 1 and it grew from 18% to 42% in the luxury cars market.

Meanwhile, the sale of Tesla EV for the past years has increase from 2000 in February in 2015 to over 89000 in March 2022, with over 44 times of increase in only 7 years. This is just the data of EVs for Tesla.

It's expected that EV sales will grow to over 10% by 2025. Top 10 EV models with the highest registration number in the USA in 2020 are shown in Table 2. As can be seen, the EVs from Tesla is leading in the market which accounts for more than 67%.

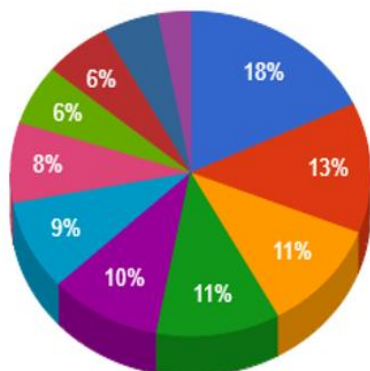
### 2.2 EV Industry in China

The market for both the traditional car and the development of EVs industry is relatively mature in China. Financial and technology supports from government have provided plenty of space for the development of EVs, such as the subsidies for battery manufacturers and \$5.82 billion for new energy vehicles in 2021. In turn, it boosts the EV market in the middle class with annul income between \$10,000 and \$60,000 in the rapidly expanding urban population.

The sale of EVs in China has similar trend as in USA as can be seen in Fig. 3A. The annual sale number for EV in China increased from 12,000 in 2012 to almost 3 million in

2013 USA Large Luxury Car Market Share

- Tesla-S
- Benz-SC
- BMW-7
- Lexus-LS
- BMW-6
- Audi-A7
- Jaguar-XF
- Audi-A8
- Jaguar-XJ
- Porsche-P
- Maserati-q



2019 USA Large Luxury Car Market Share

- Tesla-S3
- Lexus-ES
- Benz-ECLS
- BMW-5
- Audi-A6
- Lincon-MKZ
- Cadillac-XTS
- Others

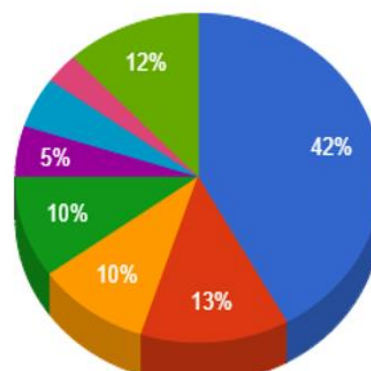
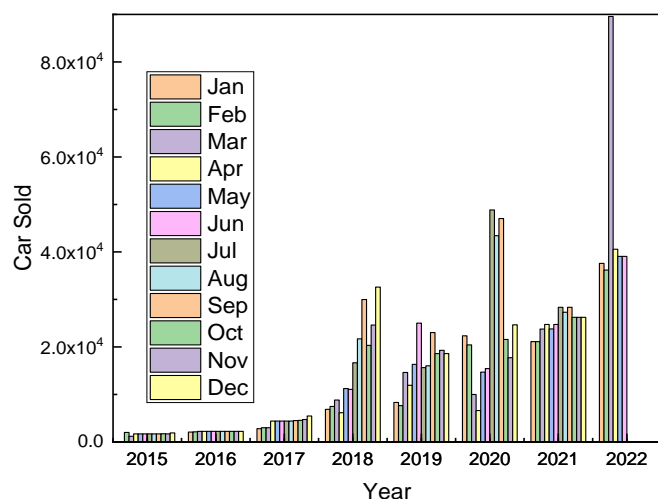


Fig. 1 The sale of Tesla EV for the past years. (Source: www.goodcarbadcar.net).



**Fig. 2** The sale of Tesla EV for the past years. (Source: www.statista.com)

**Table 2.** 2020 top 10 U.S. EV registrations.<sup>[12]</sup>

Ranking	Producer / Model	Registration
1	Tesla Model 3	95,135
2	Tesla Model Y	71,344
3	Chevrolet Bolt EV	19,664
4	Tesla Model X	19,652
5	Tesla Model S	14,430
6	Nissan Leaf	8,972
7	Audi E-Tron	7,089
8	Porsche Taycan	3,943
9	Hyundai Kona	2,964
10	Kia Niro	2,807

2021 with over 250 times increasing. Correspondingly, the annual sale for Contemporary Amperex Technology Co. Limited, one of the largest Li ion battery manufactures for EVs, increased from 0.13 billion in 2014 to over 51 billion dollars in 2022 with over 390 times growth.

Despite the rapid development of EVs, there are still

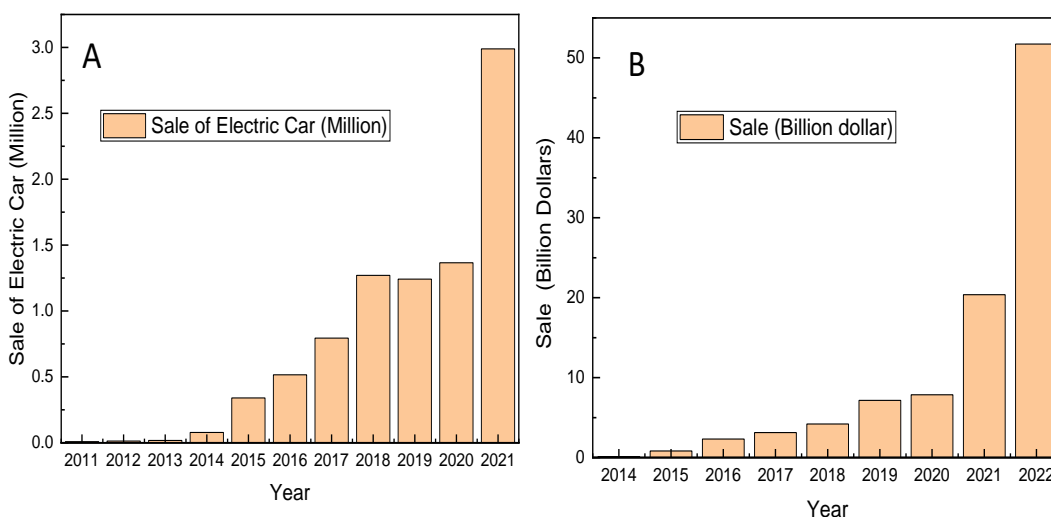
problems, such as battery issues. Due to the relatively small scale of automobile market share, the cost of EVs and batteries are relatively high. Meanwhile, the battery capacity limits the range and the supply chain affects the costs of EV a lot. On May 29, 2020, Volkswagen announced that it signed an agreement with Chinese battery manufacturer Gotion High-Tech and VW is expected to acquire 26% (1 billion Euros) of shares, which made VW the first global carmaker invested in a Chinese battery supplier.<sup>[13]</sup>

### 3. Impact of EV technology innovation

#### 3.1 Impact on traditional energy industry and environment.

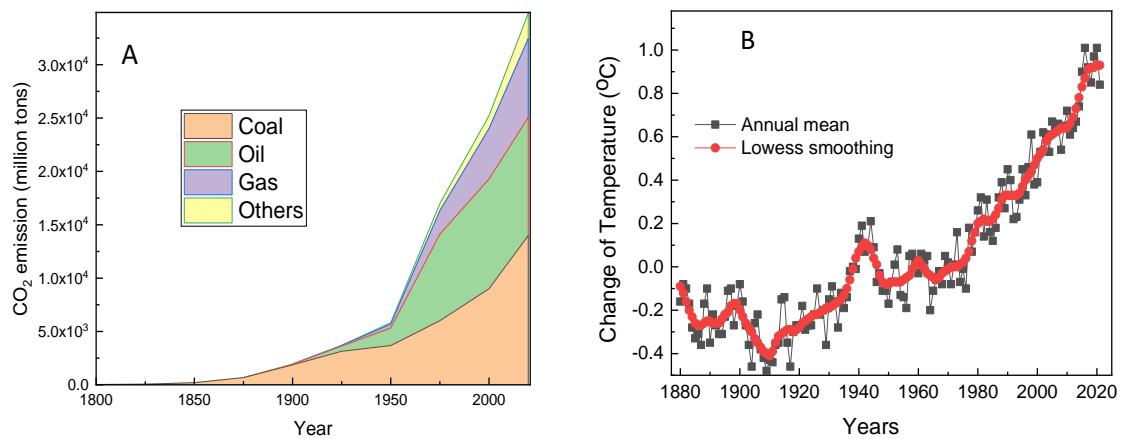
One of the most significant impacts of EVs on petrochemical industry is to reduce the dependence on crude oil. According to data from Sina Finance, the number of motor vehicles in China reached 372 million in 2020 with 40% increase from previous year. In 2019, China alone consumed 696 million tons of crude oil, of which 506 million tons were imported with a dependence rate of 72%.<sup>[14]</sup> Higher dependence rate on foreign crude oil has impact on national energy security and economic development. Thus, EVs will directly affect oil market in the short term: gradually decrease and may further decline in the future for the demand for gasoline and diesel. Therefore, the development of EVs will decrease the dependence on foreign crude oil in the long run, not only for China.

The record heat waves swept the whole planet in 2022, from Europe to China, from America to India, followed by deadly wildfires. The consuming of petrochemical energy releases the CO<sub>2</sub>, which is directly related to the global warming, not to mention the air pollution such as NO<sub>2</sub>, NO, PM 2.5 and so on. The exponential growth of the consumptions for petrochemical energy (coal, oil, nature gas and so on) is shown in Fig. 4A.<sup>[15]</sup> As can be seen in Fig. 4B,



**Fig. 3** A) The annual sale number for EVs in China; B) The annual sale for Contemporary.



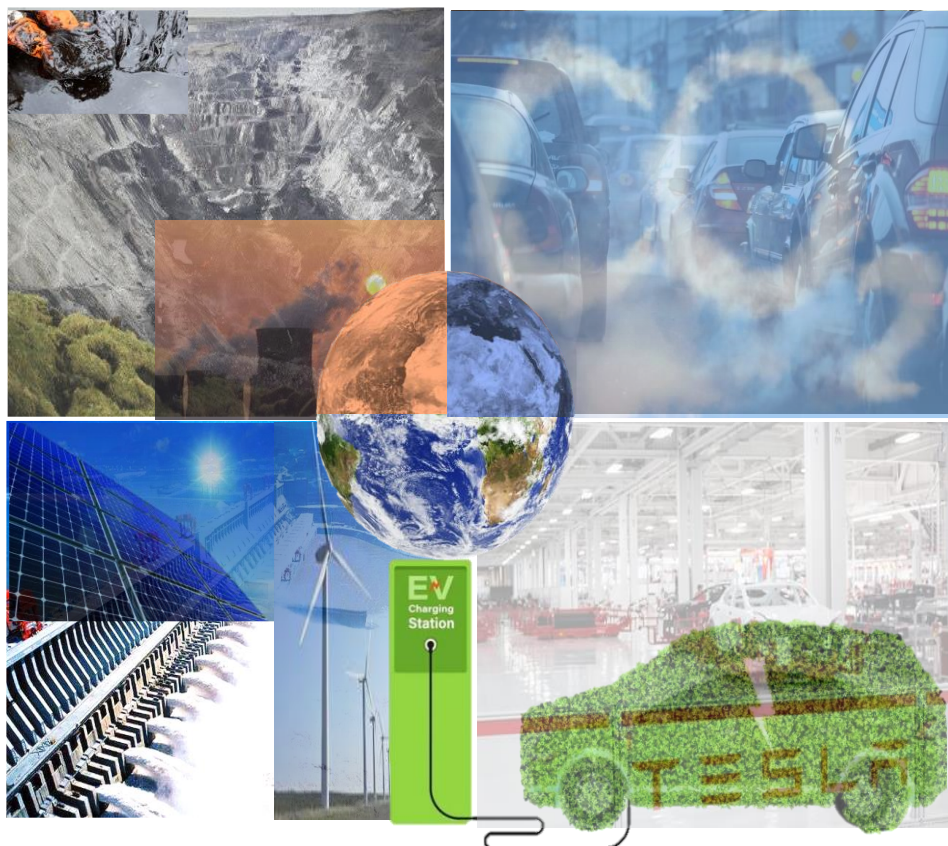


**Fig. 4** A) The exponential growth of the consumption for petrochemical energy; B) The global warming trends.

warming, not to mention the air pollution such as NO<sub>2</sub>, NO, PM 2.5 and so on. The exponential growth of the consumptions for petrochemical energy (coal, oil, nature gas and so on) is shown in Fig. 4A.<sup>[15]</sup> As can be seen in Fig. 4B, the average rising of temperature is sharing the same trend as the consumptions of petrochemical energy, which proves that the global warming is directly related to the CO<sub>2</sub> emission from petrochemical energy consumptions.<sup>[16]</sup>

As for now, internal-combustion vehicles are still dominating the automotive market, which are backed by the traditional oil and gas companies. In the long run, the development of EVs will have a devastating blow to the oil

market. The American Petroleum Institute has joined forces with Americans for Prosperity, a political group funded by Koch's oil empire to oppose the investment in EVs by utilities in Illinois and Iowa. In Massachusetts, The American Petroleum Institute partnered with gasoline sellers and convenience stores to oppose the expansion of EV charging facilities by State Grid.<sup>[17]</sup> On the other hand, the promotion of pure EVs and hybrid vehicles will be able to reduce oil consumption and reduce the CO<sub>2</sub> emissions, which in turn slows down the global warming and protect the environmental ecological balance. Fig. 5 compared the impact of internal-combustion vehicles and EV to the environments.



**Fig. 5** Comparison of the effect on environment for fuel vehicles and EVs.

### 3.2 Impact on battery industry

One of the core components for EVs is the battery as power source, the rechargeable ion battery to be specifically. The development of EV industry not only affects the traditional oil and automobile industry, but also contributes to the continuous technological advances of the 2<sup>nd</sup> battery industry. As an advanced-tech aggregate, the research and engineering rechargeable for ion battery have always been one of the focuses for EVs.

As the first generation, lead-acid battery was invented in 1859 and is still widely used even its heavy and contains corrosive acid. The second generation of alkaline batteries are popular for their small size, portability, and sufficient power; however, their waste disposal causes lots of environmental issues. The third-generation fuel cells used to be a promising technology from the perspective of energy conservation and environmental protection.<sup>[18]</sup> However, the storage of explosive/flammable gas/chemicals hinder the further application. Even though the rechargeable devices stumble to the application by overcoming the explosion, catch fire and other issues, ion batteries become the most reliable and long last rechargeable energy storage devices. Rechargeable devices include not only Li ion battery (LIB, back to 1980), but also other ion batteries (Na ion battery back to 1980s), Ni batteries and super capacitors.<sup>[19,20]</sup> LIB have one of the highest energy densities of any battery technology today and the output voltage is 3.6 V, which is 3 times higher than Ni-Cd or Ni-MH rechargeable batteries. Meanwhile, LIB does not have memory effect and has low self-discharge rate(less than 3%, comparing 10% for Ni batteries). Table 3 Summarized the current popular energy storage devices for both research and applications.

**Table 3.** Comparison of parameters for rechargeable batteries.<sup>[21]</sup>

Items	Li ion battery	Na ion battery	Ni batteries
Charge time	fast	fast	slow
Self-discharge rate (%/month)	0.35-2.5	N/A	10
Voltage (V)	3.4-3.8	2.7-3.5	1.2
Specific energy (Wh/kg)	120-300	70-150	40-60
Cost	relatively low	low	high

One of the important parameters for ion battery is the power density, which is the maximum output power per unit of weight or volume. It can be defined by a simple Equation (1):

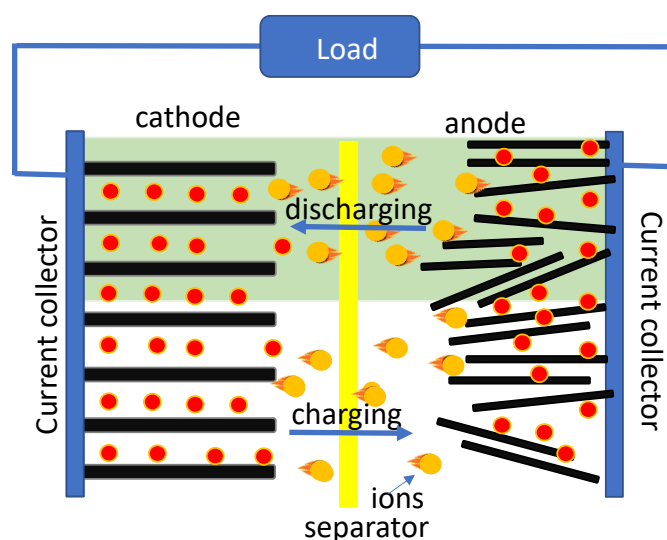
$$\text{Energy density (Wh/kg)} = \text{Voltage (V)} \times \text{Capacity (Ah)/Weight (kg)} \quad (1)$$

or a more complex Equation (2):

$$P = \frac{\int_{t_0}^{t_f} I(t)E(t)dt}{(t_f - t_0)M_t} \quad (2)$$

where  $t_f$  and  $t_0$  are the final time and original time, respectively;  $E$  is the potential and  $M$  is the weight. As can be seen, the lighter the battery is, the higher the energy density is and lighter weight also reduce the load for EVs. The atomic mass of lithium in LIB is 6.94 u, comparing with 207 u for lead in lead-acid battery.

The other energy storage devices include Mg ion battery, K ion battery and Zn ion battery have the similar mechanism as LIB, which is the reversible diffusion of ions in the electrolytes between two electrodes while charging and discharging.<sup>[22]</sup> Usually, the solvents for electrolytes are flammable organic solvents. The mechanism can be seen in Fig. 6. The cathode materials can be layered materials, such as graphite. On the other hand, the anode materials can be varied. They are usually Lithium salts, such as Lithium Nickel Cobalt Aluminum and Lithium Iron Phosphate.



**Fig. 6** The mechanism of rechargeable ion batteries.

As the technologies iterating, the energy conversion efficiency, specific energy and specific power of the LIB keep increasing. It is also becoming more environmentally friendly and safer. The operation of LIB is strictly limited by temperature and voltage. Exceeding certain limits will not only result in a rapid degradation of battery performance, but also cause severe fire or explosion. Overheating, inappropriate charging (overcharge/over-discharge and charging rate) cause dendritization in LIBs, which penetrate the separator shown in Fig. 6. The peak temperature for LIBs during overcharge/over-discharge increased with the increase of charging/discharge rate. The larger the rate is (fast charging), the severer the temperature rises. Even though the overcharging can be

avoided by the design in the circuit of charger, it should be avoided. Usually, the over deposition of lithium ions in the anode and internal short circuit during the overcharge causes the failure of LIBs. Meanwhile, the over-discharge results in the copper foil dissolution and the formation of Cu dendrites also cause the failure of the LIBs. To address these issues, new technologies are gradually helping to overcome them and improving the performance of ion batteries, such as lithium oxygen LIB, lithium air LIB, aluminum ion battery, sodium ion battery and aqueous based ion batteries.<sup>[23]</sup> With these new technologies, the ion batteries will be safer, fast charging, and the driving range will surpass fuel vehicles just a matter of time. Table 4 is an example of improvement for the LIBs in Tesla EVs, such as energy density.

**Table 4.** Different LIBs on different models of Tesla EVs.

Tesla battery	18650	2170	4680
Model	M-S, M-X	M-3	newest
Length × Diameter (mm)	65 × 18	70 × 21	80 × 46
Weight (g)	47	68	355
Voltage (V)	3.7	3.7	3.8
Electric charge (mA h)	3500	4800	26136
Energy density (Wh/kg)	240	247	305
Anode material	Lithium nickel cobalt aluminum oxide (NCA)	Lithium nickel cobalt aluminum oxide (NCA)	Lithium iron phosphate (LFP)
Cathode material	Graphite	Graphite	Graphite

Source: <https://cleantechnica.com>; [www.dnkpover.com](http://www.dnkpover.com).

Attention should be also paid to the pollution caused by the waste from batteries. In estimate, China had more than three times as much existing and planned lithium-ion battery recycling capacity as the USA in late 2021.<sup>[24]</sup> According to Xiaorong Zhang, director of the Cutting-Edge Technology Research Institute in China, a 20-gram cell phone battery can pollute up to 1 square kilometer of land for about 50 years if it's not handled properly. The life span of lithium-ion batteries for EVs is about 6–8 years. It has been suggested that China will reach a peak of battery replacement in 2025.<sup>[25]</sup> China began promoting lithium-ion battery recycling in 2012 and added policy in 2018 to require manufacturers to collaborate with recycling companies to improve the recycling process. In August 2022, a USA company (Ascend Elements) invested up to \$1 billion in Southwest Kentucky to recycle cathode active materials for up to 250,000 EVs per year. Based on a new technology, the cathode materials from a used battery are dissolved in acid and impurities are removed.<sup>[26]</sup> Next, a touch

of fresh elements composing the cathode, such as nickel and cobalt, is added to carefully re-balance the ratio of ingredients. It is found that the recycled powder particles were more porous, which provides room for the cathode crystal to swell slightly as lithium ions squeeze into it. The associated larger exposed surface area due to higher porosity allows these batteries to charge faster than their commercially manufactured counterparts. In the near future, more advancements in this aspect are expected to better address the environmental issue of waste batteries.

### 3.3 Impact on traditional automobile industry and autonomous driving

#### Traditional automobile industry's anxiety

The sales of EVs keep squishing the market share of the traditional fuel vehicles. The COVID-19 pandemic affects the passenger car sales, however, the sales for EVs keep breaking the records in China, USA, Europe and other part of the world. As seen in Fig. 7A, the sales of passenger car keep decrease in USA from 2014 to 2020, however, the sales for EVs increased dramatically. The trend is even more obvious in Europe (Fig. 7B) and China (Fig. 7C).

The global market share for EVs in 2014 was 0.41% and it grow more than 25 time to 8.57% in 2021.<sup>[27,28]</sup> The EVs companies, such as Tesla in USA and NIO in China, are taking up the market from traditional automobile enterprises and forcing them transform to EVs. Meanwhile, the development of EVs will completely change the traditional auto parts supply system. The easier assemble procedures for EVs require 20% less parts and components than fuel vehicles. For example, the application range of rubber parts will be reduced a lot, radiator and cooling system for combustion engine no longer needed in EVs. Therefore, breakthroughs in EVs technologies are causing a revolution in the automotive industries. As the trend of EVs replacing the fuel vehicles keep going, most of the traditional automobile companies starts to develop their own EVs. Table 5 shows the EV product for some traditional automobile companies, such as Chevy and BMW.

**Table 5.** Current EVs produced other than Tesla and comparison (Source: [www.teslarati.com](http://www.teslarati.com)).

EV	Battery Weight (kg)	Battery Capacity (kWh)	Driving Range (mile)
Tesla-3	439	75	310
Chevy Bolt	436	60	259
Jaguar-I	599	90	234
Audi-e-tron	700	95	218
BMW i-3	485	22	81

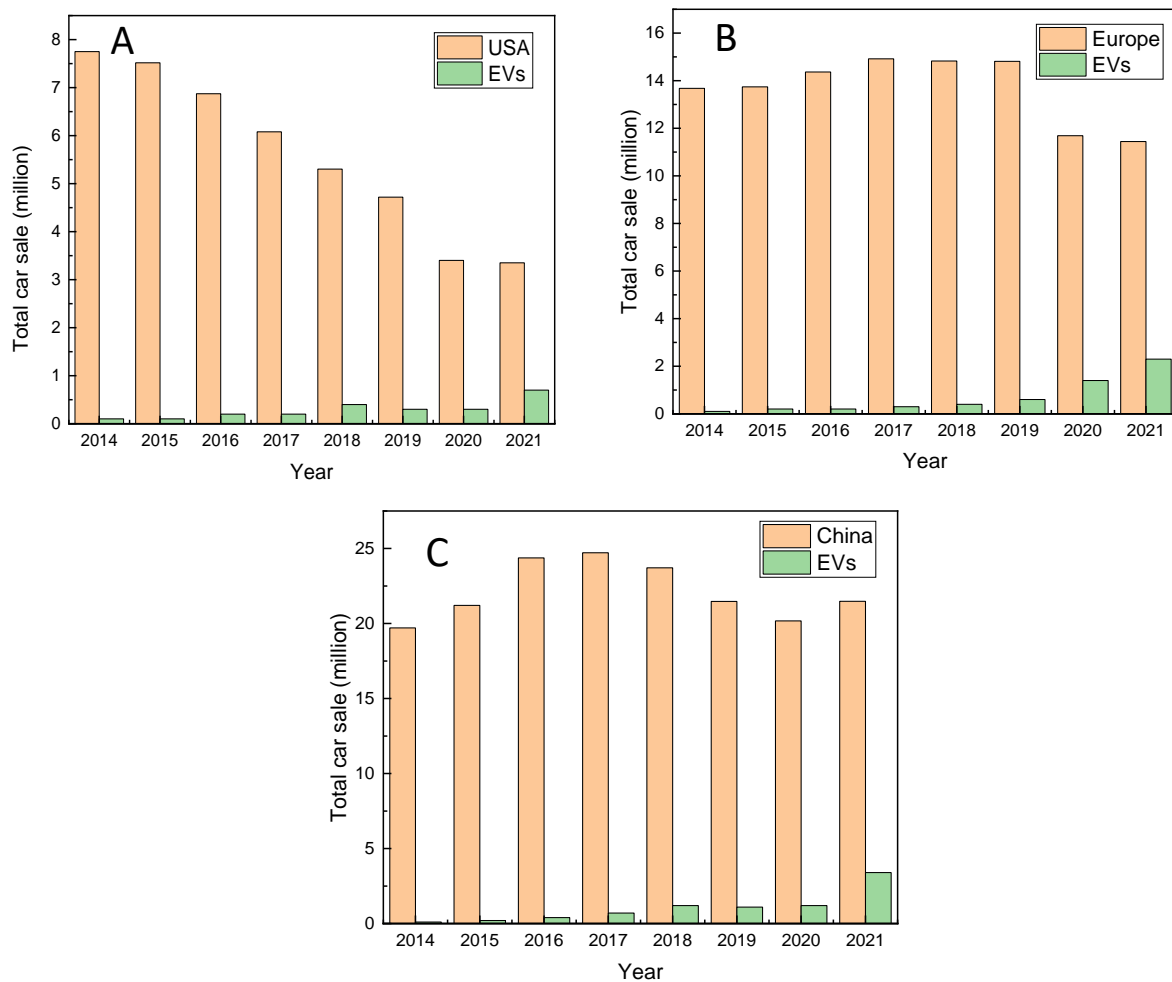


Fig. 7 The passenger car sales for the past years and the increase of sales for EVs in USA, Europe and China.

**Autonomous driving**

Autonomous technology used in EVs is about to bring revolutionary changes. Combining the computer and internet technical support such as 6 G, the effective configuration of power system and the service capability of charging facilities also play a fundamental and critical role. These "cross-border" collaborations brought about by the latest technologies will provide the best transportation options for the creation of energy-saving and environmentally friendly cities in the future. With current technologies, the combination of autonomous driving technology and EVs will be more advantageous. Autonomous driving EVs can solve these problems by autonomously finding the nearest or most suitable charging facility automatically. As the power density for the battery keeping increase, the range issue for EVs is solved and the requirements for charging facilities decreased. Moreover, wireless charging for EVs is on the way as the technology advanced.

**3.4 New energy-saving and environmentally friendly urban life**

As the future autonomous driving and 6G technology are fully mature, autonomous driving EVs will become the best choice for future urban transportation. The fourth-generation General Motors (GM) Cruise AV doesn't have driver's seat, which is the latest generation of autonomous driving EVs. Not only the ride experience inside the car, but also the environment will be greatly improved as well. For example, autonomous driving EVs reduce the need for private ownership of cars, which can reduce car ownership and thus save energy and protect the environment. The spread of autonomous driving EVs could even help achieve urban planner Ebenezer Howard's idea of "green garden city", a concept he formalized in 1898 in his book *To-morrow: A Peaceful Path to Real Reform*, which argued that people should live in places that combine the best aspects of urban and rural areas.<sup>[29]</sup> Low density urban spatial form will be an important factor to obtain a good life experience. In addition, under the premise that the technology is advanced enough, the comprehensive popularization of autonomous driving EVs in the future will effectively reduce the occurrence of extremely serious and even conventional traffic accidents and jams. The casualties avoided due to the



decrease in traffic accidents will improve the welfare level and life safety of the whole society.

According to Jeremy Carlson, principal analyst at IHS Markit Automotive, the convergence of personal travel choices and the diversity of autonomous driving technologies will have new implications for society. He believes that autonomous mobility services could serve the young, elderly, disabled and others without reliable transportation to get around daily.<sup>[30]</sup> Therefore, the popularization of autonomous driving EVs in the future will bring major changes to the life and urban morphology of the entire city.

#### 4. Conclusion

Fossil resources are non-renewable and lots of other critical industries depend on them not only automobile industries, such as synthetic chemistry, medical industries and so on.<sup>[31]</sup> Thus, EVs have received unprecedented attention not only due to pollutions global warming. Even though there are lots of challenges, the future of the EV industries is very optimistic. With the improvements in ion battery, more charging poles, and other technologies such as photovoltaics, the EVs in the future will be less expensive and the driving range will surpass the fuel vehicles. They are facing great opportunities and even it cannot be stopped by the COVID-19 pandemic, which caused and is still causing catastrophic disasters for lots of businesses.

Combining with innovations in sodium/aluminum ion batteries, aqueous based ion batteries, 6 G and autonomous driving, EVs will overcome the driving range and charging time shortcomings and outperform the fuel vehicles. There is no doubt that the emergence of EVs poses a tremendous threat to the survival of oil giants and traditional automobile businesses. As a result, traditional industries must change accordingly. It is of great significance to achieve a new zero CO<sub>2</sub> emission and environmentally friendly life. For better life, for better world.

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#### Conflict of Interest

The authors declare no conflict of interest.

#### Supporting Information

Not applicable.

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