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Analysis of the current situation and challenges of the popularity of new energy vehicles

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Abstract. In order to solve the problem of greenhouse gas emissions generated by burning fossil fuels, countries around the world are actively promoting new energy vehicles. This paper elaborates on the current situation of global new energy vehicles through literature analysis, compares the advantages of new energy vehicles with traditional vehicles, and reveals the challenges faced by new energy vehicles based on this. The results showed that the number of new energy vehicles worldwide is gradually increasing, and the government is actively promoting the widespread application of new energy vehicles. Compared with traditional fuel vehicles, new energy vehicles can effectively solve the exhaust problem of traditional vehicles and save the cost of exhaust gas treatment. However, new energy vehicles face the challenge of a lack of appropriate energy storage systems, efficient Battery management systems and high-performance fast charging facilities. The increase in the popularity of electric vehicles depends on providing incentives and government policies. To upgrade the sales of new energy vehicles, manufacturers must pay attention to diversity and create attractive new energy vehicles.

Keywords: Automotive Exhaust, New Energy Vehicles, Current Situation, Challenges.

1. Introduction

The burning of fossil fuels has resulted in greenhouse gas emissions at dangerous levels posing a threat to human health, necessitating prompt preventative measures. A significant 2% of the global transportation sector is currently dependent on oil, which alone consumes 90% of oil production. This sector is the fastest-growing energy consumer worldwide. Hence, it is critical to electrify road vehicles to combat environmental issues [1].

New energy vehicles (EVs) are widely acknowledged as one of the most promising solutions to the challenges posed by climate change and environmental pollution. Robert Anderson created the first electric vehicle between 1832 and 1839, using a non-rechargeable primary battery [2]. Subsequently, he developed other prototypes, which proved unsatisfactory due to a dearth of practical rechargeable batteries and efficient electric motors. In 1900, electric vehicles constituted 28% of the vehicles in use on the streets of New York City, thanks to the enhanced technology of rechargeable lead-acid batteries and DC motors. These vehicles enjoyed a period of popularity until 1918. However, by 1933, no electric cars remained on the roads, as they were deemed too slow and internal combustion engines had become considerably more expensive. Vehicles equipped with internal combustion engines discharge carbon dioxide, carbon monoxide, hydrocarbons, and sulfur oxides, which, via the greenhouse gas effect and

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pollution, contribute to global warming, an environmental hazard that endangers both the natural environment and humanity. Therefore, it is essential to implement new energy vehicles to eliminate pollution. This paper analyses the global state of new energy vehicles using literature review and identifies their challenges. This paper can raise awareness of new energy vehicles and give some references for future research.

2. The global state of new energy vehicles

The number of electric vehicles on the road has increased from just a few hundred a decade ago to more than 5.2 million in 2018, with 3 million already in use in 2017 [1]. China currently leads in electric vehicle deployment with the highest number and percentage of sales, at 45%. Europe and the United States follow closely, with 24% and 22% respectively [3]. At the conclusion of 2018, the transport sector in China experienced an addition of 1.1 million fresh electric vehicles. Table 1 presents the present status and objectives of electric vehicles in diverse nations. A comparison was made with the data from 2010. Table 2 elucidates the grounds for the global rise of electric vehicles.

Table 1. The electric vehicle goals set by different countries that are expected to be achieved by 2050 and their comparison with past commitments [4, 5].

Nations	Target (issued in 2010)	Status in 2020	Target 2050
Austria	2020: 100,000 electric vehicles deployed	2018: about 25,000; 2020: 6.7 per cent of new energy vehicle sales in February	
Australia	2012: first cars on the road, 2018: mass deployment, 2050: up to 65 per cent of car inventory	2019: 1,277 sold 2018: 670 sold	2030: 50 per cent of new cars will be electric
Canadian	2018: 500,000 new energy vehicles deployed	2019: 93,091 electric vehicles on the road and 125 per cent increase in electric vehicle sales over 2017	Sales of new light-duty zero-emission vehicles: 2025: 10 per cent; 2030: 30 per cent; 2040: 100 per cent
sino	2011: 5 million EVs produced annually	2011: 8,159 EVs, 331,092 sold in 2015.	Year 2400: 40 per cent of global electric car sales
Denmark	2020: 2 million vehicles	2020: 15,000 EV charging stations accommodating 50,000 EVs 2019: 4,618 BEVs and 3,623 PHEVs sold.	2050: Transport sector to be independent of fossil fuels
French	2020: 2,000,000 EVs	2018: 2 per cent of licence plates are for PHEVs or all-electric vehicles	2040: Ban on fossil-fuelled cars, which will start in Paris in 2030.
German	2020: 1,000,000 EVs deployed	2019: 24,000 public charging stations	2030: 10,000 charging stations
Irish	2020: 10 per cent market share of electric vehicles	2019: 4,825 electric vehicles on the road and another 4,054 registered	2030: 10,000 electric vehicles
Israeli	2011: 40,000 EVs, 2012: 40,000 to 100,000 EVs	2025: 177,000 electric vehicles on the road	2030: Full shift to electric vehicles

Table 1. (continued).

Nations	Target (issued in 2010)	Status in 2020	Target 2050
Japanese	2020: 50 per cent market share of next-generation vehicles	2017: 0.4 per cent market share for EVs	2030: 20-30 per cent market share of BEVs and PHEVs
New Zeeland	2020: 5 per cent market share, 2040: 60 per cent market share	2021: 64,000 electric vehicles	2030: EVS account for 100 per cent of new cars 2050: 100 per cent of light-duty cars are EVs
Spanish	2014: 1,000,000 EVs deployed	2018: 8,000 electric vehicles	2040: ban on sale of diesel, petrol, hybrid cars 2050: permanent ban
Sweden	2020: 600,000 electric vehicles deployed	2019: PHEVs account for 11 per cent of market share	2030: Stop using fossil fuel cars 2045: Carbon neutral
United Kingdom of Great Britain and Northern Ireland	No target figures, but there are policies to support electric vehicles	Transport sector accounts for 27 per cent of GHG emissions	zero emission
United States of America	2015: 1,000,000 PHEV inventory	2011: 9,750 units sold 2015: 71,044 units sold	Los Angeles aims for 100 per cent electric cars

Table 2. Electric vehicle subsidies in different countries [6].

Nations	Government Subsidy
Austrian	BEV price of 3,000 euros, up to 50,000 euros for private use and 60,000 euros for commercial use Cargo Bike 400 euros
Australia	Stamp duty exemption for all-electric vehicles and 20 per cent discount on annual EV registrations
Canadian	EV price of $5,000 with a maximum of $45,000 (for six-passenger or smaller)
sino	$3,500 for a purely electric car
Denmark	No tax on BEVs until 2015
French	Applies to vehicles emitting less than 20 grams of carbon dioxide per kilometre, two- or three-wheeled vehicles 900 euros, up to 6,000 euros for individuals, with a list price of 45,000 euros
German	Electric cars cost 6,000 euros (about $6,700) and 40,000 euros ($44,500)
Irish	5,000 euros for pure electric vehicles and plug-in hybrids
Israeli	
Japanese	Electric car $7,770
New Zeeland	EV NZD 8,000 (USD 4,880) price tag €5,500 €48,400

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Table 2. (continued).

Nations	Government Subsidy
Spanish	Pure Electric Vehicle 5700 EUR Pure Electric Vehicle 6600 USD
Sweden	FCEV $18,600
South Korea (Republic of Korea)	Pure electric car £3,500
United Kingdom of Great Britain and Northern Ireland	Pure electric vehicle $2500
United States of America	Plug-in hybrids $1,500

3. New energy vehicle

3.1. Hybrid electric vehicles and plug-in hybrid electric vehicles

Hybrid Electric Vehicles (HEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) are powered by auxiliary electric motors and petrol internal combustion engines.

In HEVs, the electric motor is only involved in starting and accelerating the vehicle. HEVs have a limited battery capacity, which is recharged by deceleration or braking. Compared to traditional diesel and petrol vehicles, hybrid electric vehicles (HEVs) are widely perceived to be twice as fuel-efficient. Additionally, they are far less polluting than standard fuel-powered vehicles, as they do not consume electricity from the grid. In HEV models, propulsion is provided by the electric motor, and the battery recharges via fuel-generated power. As such, the HEV range is an ideal solution for high-frequency stopping and starting, making them particularly suitable for urban areas. The parallel hybrid electric motor and internal combustion engine (ICE) are linked mechanically, transmitting power to propel the vehicle. Due to their complementary qualities, parallel HEVs are well-suited for both urban traffic and highway driving modes. Series-parallel HEVs, on the other hand, can operate in either series or parallel mode, hence the ICE and the electric motor are merged with the wheels and transmission, leading to a costly and intricate combination.

A plug-in hybrid electric vehicle (PHEV) is an electric vehicle that combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system that can be recharged from an off-vehicle electric source. The vehicle's battery can be charged by simply plugging it into an electrical outlet, and when the battery runs low, the ICE takes over. This allows the vehicle to operate using either electricity or gasoline, leading to lower emissions and greater fuel efficiency. Plug-in hybrid electric vehicles have a highly efficient internal combustion engine (ICE) and a high-capacity battery pack. These vehicles also come in various driveline configurations, including series, parallel, and series-parallel, with additional on-board battery chargers. PHEVs have two modes of operation, charge depletion and charge maintenance. They start in charge depletion mode, but when the battery state of charge becomes low, they switch to charge maintenance mode, which causes the ICE to operate.

3.2. Pure electric vehicles

Electric vehicles lack conventional engines, fuel tanks, exhaust pipes, and on-board power generators, thus making them free of tailpipe emissions. These vehicles can be powered by any type of power plant, including renewable energy, and offer sufficient acceleration without compromising on environmental impact. Time-consuming battery charging and expensive electricity, however, restrict the widespread availability of these vehicles. It is crucial to consider the manufacturing and disposal of batteries and the carbon intensity of power generation during their use. Before universal market penetration, charge point infrastructure and the corresponding investment must be in place. There is a growing consumer interest in electric vehicles, as evidenced by a user satisfaction survey.

3.3. New energy vehicle batteries

The battery is a key component of electric vehicles, with normal operating temperatures typically ranging from +15 ℃ to +30 ℃. However, ambient temperatures may fluctuate between -35 ℃ and +50 ℃ due to varying climates and locations. Heat transfer and dissipation are the main processes that control battery temperatures when generating heat, making efficient thermal management essential for electric vehicle batteries [7]. Table 3 presents an overview of the various energy storage systems currently employed in electric vehicles.

Table 3. Other technical characteristics of all selected ESTs [8, 9].

Environmentally sound technologies	discharging time	response time	life span	Daily Leakage
PHS	1-24 hr+	sec-min	40-60	Very small
FES	ms-15 min	< 4 ms-sec	15 +	24-100
CAES	1-24 hr+	1-15 min	20-40	Small
Pb-A	sec-hr	5-10 ms	5-15	0.1-0.3
Ni-Cd	sec-hr	20 ms-sec	10-20	0.2-0.6
Na-S	sec-hr	sec	10-15	20
NaNiCl2	sec-h	< sec	10-14	11.89-26.25
Li-ion	min-hr	20 ms-s	5-15	0.1-0.3
VRFB	sec-10hrs	Sec	5-10	Small
SCES	ms-hr	8 ms	20 +	20-40
SMES	ms-8 sec	<100ms	20 +	10-15

4. Challenges in promoting new energy vehicles

4.1. Technological challenges

New energy vehicles offer many advantages, but the extended charging time poses a significant challenge for electric vehicles. An additional problem for electric vehicles is the lack of standardisation for their connectors. The connectors for EV chargers come in various shapes, sizes, and pin arrangements, depending on the country/region and EV manufacturer. Hence, the charging stations and batteries in vehicles must share the same design or brand. Furthermore, the decrease in revenue resulting from significant investments has hindered the development of charging infrastructure. At present, there exist two international standards for rapid charging: Society of Automotive Engineers (SAE)’s International's Combined Charging System (CCS) and the CHAdeMO protocol, which is used by German and American industries and Japanese car manufacturers, respectively [10].

In many instances, the range offered by companies is unrealistic and typically 17% lower than the anticipated range. Ultra-fast charging facilities are emerging, capable of fully charging a depleted electric vehicle in under ten minutes with a capacity of 350 kW, providing up to 200 kilometers of range. This breakthrough in electric vehicle charging technology is pivotal for promoting the widespread adoption of electrified transportation. Electric vehicles face an obstacle in their long charging times as cars cannot yet receive high currents without damage. Long queues at charging stations also pose a problem. However, implementing a "battery swap" system at planned replacement stations could alleviate these issues. This service would replace discharged batteries and provide a fully charged battery in minutes, similar to a fully charged battery. A fully charged battery can be supplied to an electric vehicle in just a few minutes, much like refuelling. This significantly extends the range of the vehicle.

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4.2. Consumer performance

The implementation of electric vehicles largely depends on consumer behaviour. Factors such as willingness to purchase and use, consumer readiness, and willingness to pay and accept affect the widespread adoption of EVs. There is ongoing debate surrounding how factors such as customers' gender, age, education level, income, and occupation have an impact on electric vehicle purchases. From literature-based studies, it is evident that highly educated male consumers in their youth and middle-age are more inclined towards adopting electric vehicles. Technical education or profession increases the possibility of electric vehicle consumption [11].

Furthermore, the varied models of electric vehicles can attract a wide range of audiences. The absence of diverse electric vehicle models is the reason why the current electric vehicle market fails to inspire people from different backgrounds. Variations in electric vehicle range, style, attractive features, and functionality have the potential to appeal to a broader range of consumers. The number of cars and household members significantly affects electric vehicle consumers. However, it remains uncertain whether owning more than one car ultimately influences the perception of purchasing an electric vehicle.

4.3. Government policies

Lucrative government schemes and incentives can accelerate the expansion of electric vehicles (EVs) in the worldwide market. Tax breaks and subsidies are appealing when buying an EV. However, EVs can only be competitive if internal combustion engine vehicles are subject to a higher tax rate than EVs, similar to Norway and Denmark's tax policies. In fact, Norway leads the way in the adoption of new energy vehicles. In Norway, 180,000 new energy vehicles were registered, making up roughly 10% of the new car sales in 2015. Certain countries, like Singapore, possess lower rates of using new energy vehicles, due to the high taxes imposed on them by the government. The policies instituted by the government, such as financial incentives, free parking, driving privileges, and tax incentives, have resulted in a favourable influence on the intentions of consumers to purchase electric vehicles [5].

5. Conclusion

This thesis examines the current global status of new energy vehicles using a literature analysis method. It evaluates the benefits of new energy vehicles against traditional vehicles and identifies the challenges that new energy vehicles face. The research concludes that new energy vehicles are true zero-emission vehicles. However, the inclusion of battery storage increases their weight. The lack of appropriate energy storage systems, efficient battery management systems, and high-performance fast charging facilities compared to traditional fuel vehicles poses fundamental challenges to the proliferation of new energy vehicles. The willingness of consumers to use these vehicles is influenced by their socio-economic background and willingness to pay. To boost sales of new energy vehicles, manufacturers must focus on diversity and create appealing products. This thesis lacks sufficient content for comparing new energy vehicles and traditional car accessories. Future research could provide a more detailed comparison between new energy and traditional vehicles.

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