# Recent Developments in Electric Vehicles

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***Abstract-* – This paper provide an overview of the recent work of electric vehicle in the region. The paper describes the development and the comparison of different part of components. The major components in battery technology, charger design, motor, steering and braking are examined. The paper finally shows some electric vehicle prototype as a conclusion of the papers**

***Index terms-* Electric vehicle, AFS, steering system, braking system, ABS, battery management systems, BMS, Inverter**

## I.INTRODUCTION

Electrical vehicle (EV) based on electric propulsion system. No internal combustion engine is used. All the power is based on electric power as the energy source. The main advantage is the high efficiency in power conversion through its proposition system of electric motor. Recently there has been massive research and development work reported in both academic and industry. Commercial vehicle is also available. Many countries have provided incentive to users through lower tax or tax exemption, free parking and free charging facilities.

On the other hand, the hybrid electric vehicle (HEV) is an alternative. It has been used extensive in the last few years. Nearly all the car manufacturers have at least one model in hybrid electric vehicle. The questions come to us: Which vehicle will dominate the market and which one is suitable for future? This paper is to examine the recent development of electric vehicle and suggest the future development in the area.

## II. THE KEY COMPONENTS IN EV

The electric vehicle is rather simple in structure. The key components are the propulsion parts. Fig 1 shows the configuration.

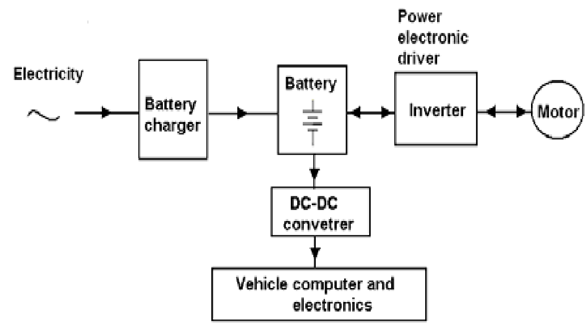


Fig 1: The key components of an Electric Vehicle.

The battery is the main energy storage. The battery charger is to convert the electricity from mains to charge the battery [3]. The battery voltage is DC and I is inverted into switched-mode signal through power electronic inverter to drive the motor. The other Electronics components in a vehicle can be supplied to the battery through DC-DC converter that step down the voltage from the battery pack to lower voltage such as 5V-20V.

## III. THE MOTOR

There are a number of motors available for electric vehicle: DC motors, Induction motor, DC brushless motor. Permanent magnetic synchronous motor and Switched reluctance motor.

1. DC motors:

It is a classical motor and has been used in motor control for a long time. All the power involved in electromechanical conversion is transferred to the rotor through stationary brushes which are in rubbing contact with the copper segments of the commutator. It requires certain maintenance and has a shorter life time. However, it is suitable for low power application. It has found applications in electric wheel-chair, transporter and micro-car. Today, most of the golf-carts are using DC motors. The power level is less than 4kW.

2. Induction motor

It is a very popular AC motors [4]. It also has a large market share in variable speed drive application such as air-conditioning, elevator or escalator. Many of the higher power electric vehicles, for more than 5kW, uses induction motor. Usually a vector drive is used to provide torque and speed control.

3. DC brushless motor

The conventional DC motor is poor mechanically because the low power winding, the field, is stationary while the main high power winding rotates. The DC brushless motor is "turned inside out [5]-[6]. The high power winding is put on the stationary side of the motor and the field excitation is on the rotor using a permanent magnet. The motor has longer life time than the DC motor but is a few times more expensive. Most of the DC motor can be replaced by the brushless motor with suitable driver. Presently, its applications find in low power EV

## IV. ENERGY STORAGE

1. Batteries

The battery is the main energy storage in the electric vehicle. The battery in-fact governs the success of the electric vehicle [9]. Recently there are massive works being reported in battery development. The battery such as Li-ion is now being used by new generation of electric vehicle. The danger of the instability of the battery has been studied by many reported. It seems that the LiFePO4 type is preferable because of its chemically stable and inherently safe. Other Li-ion such as LiCoO2, LiMn2O4 and Li (Ni1/3Mn1/3Co1/3)$O_2$ may has the thermal and overcharge concern [10]. For low cost solution, the lead-acid battery is still dominant part of the market. The battery has found applications in electric wheel chair, Golf-cart, micro-car and neighborhood town air. The recent RoHS has also stopped the use of NiCd battery.

All the research is looking towards the fast charging for batteries. MIT reported [11] the technology of a crystal structure that allows 100 times of charging speed than conventional Li-ion battery. Other alternative is to use ultra-capacitor.

2. Ultra-capacitor

Capacitor is basically a static component. There is no chemical reaction in the components. Its charging and discharging speeds are very fast. However, the energy storage is limited. Its energy storage density is less than 20% of the lead-acid battery. Although the expected ultra-capacitor density will go up in next few years, its total solution for main energy storage is a challenge. The number of cycles and the temperature range is excellent. Table 1 shows the comparison.

Table 1: Comparison of different energy storage unit

| | Lead-acid | NiMH | Li-ion | Ultra-capaCitor |
|---|---|---|---|---|
| Energy density Whr/kg | 40 | 70 | 110 | 5 |
| Cycle life | 500 | 8,00 | 1,000 | 500,000 |
| Working temperature(°C) | -30 ~+50 | -40~+50 | -40~+60 | -40 ~ +85 |
| Cost $/kWhr | 1,000 | 2,400 | 5,000 | 50,000 |

Therefore ultra-capacitor is useful for fast speed or transient energy storage. As it allows high current charging, its charging time can be shortened to within a few minutes.

The ultra-capacitor is still in the initial stage of development. It is expected that the cost will be going down and the energy density will go up rapidly in next few years.

## V. CHARGING SYSTEMS

1.General charger:-The charger needed for the battery system for slow charging or fast charger are both required to handle high power. The H-bridge power converter is needed [12]. Fig 2 shows the converter. The converter is famous for its efficiency and has found application in charger and DC-DC converter.

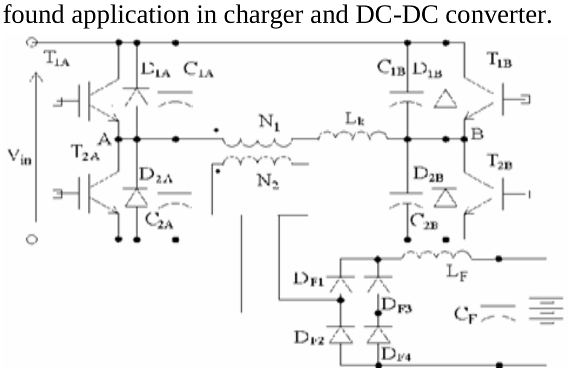


Fig 2: The H-bridge converter for charger

2. Ultra-capacitor charger

The voltage on the ultra-capacitor various from the full-voltage to zero when nits energy storage varies from full to zero. This is different from the battery as its voltage will only varies within 25%. The capacitor voltage is internal point and is not in contact with users. The transformer isolated converter is not necessary. A tapped converter should be used as it will have higher efficiency for power conversion [13]. The efficiency of the power converter is higher than the transformer-isolated version. The structure is simple.

3. Battery management systems

It is also referred as BMS. The battery system is formed by a number of battery ells. They are connected in parallel or series that is according to the design. Each of the cell should be monitoring and regulated. The conditioning monitoring includes the voltage, current and temperature. The measured parameters are used to provide the decision parameter for the system control and protection.

Two parameters are usually provided. They are the state of charge (SoC) and the State of Health (SoH). SoC is like the oil tank meter that provides the battery charging condition. It is measured by the information of voltage and current. The SoH is to record the health or aging condition.

## VI. CHARGING NETWORK

1. Charging network

The charging method of EV is controversial because of the uncertainty of the power needed, location and the charging time. The charging time of batteries has been reported to be shorter in the recent development. The lead-acid batteries are restricted by its technology. The charging rate is less than 0.2C and quicker charging rate seriously shortens its life time. Other battery such as Li-ion has recommended charging rate of 0.5C.

Usually most of the electric vehicles have an on-board battery charger. A power cable is connected from the vehicle to a charging point. A charging station should provide a number of power points and a suitable transaction program to calculate the tariff.

The power needed for the charging station is not a concern. Usually for private car, a standard charging power is less than 2.8kW. Single-phase power line is used. In average a vehicle is needed to be charged every 3 days. Using Hong Kong as an example, it will only affect the power consumption of less than 2% even all the private cars are charged to EV.

2. Fast charging station

For fast charging, a high current is needed, therefore three-phase power is usually used. The charging station should consider the method to connect the 3-phase socket to users as not all the civilian can handle the use of 3-phase socket system. The following has been discussed:-

a. Magnetic contactless charging: There is no metal contact, all the power transfer is through magnetic induction. This reduce the concern when a civilian to handle high power cable and he/she does not need to contact the conductors.
b. High voltage power transfer: The heavy and large 3-phase socket and cable can be reduced in size by high voltage connection. The power source is stepped up to high voltage of several kV, and the cable is reduced. There is another step-down converter in the vehicle that reduced the high voltage to suitable lower voltage to charger the battery.
c. Battery rental: This has been suggested from the 1st day of the promotion of EV. All the batteries are not owned by the users but on a rental arrangement. Users go to charging station to swap the batteries to fully-charged ones. The time needed is just a few minutes. The design of the EV should be made for such changes. The vehicle battery charging in the station can also be used for energy storage to ease peak demand through valley supply compensation.

## VI. CONCLUSION

This paper discusses the recent development in electric vehicle. The paper first describes general structure and discusses the energy storage. It then extends to the future vehicle components. The paper provides an overview of the recent EV work in the region.

## VII. ACKNOWLEDGEMENT

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