Expert Conference: Electric car/truck: Future concepts with just-in-time energy reception

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1 Introduction

The growing climate crisis makes countries shift direction regarding personal transportation. For example some European countries have decided to ban sales of petrol and diesel cars by the following decades. Car manufacturers are doing the same such as Volvo which said it would manufacture only fully electric or hybrid cars from 2019. Following this idea, we wondered what are the possible technologies that could improve electric vehicles, especially the regarding the battery charge time.

2 Current Technologies

Nowadays, electric cars are getting more and more popular around the world, mostly because the cost of production of the batteries is decreasing and the autonomy is increasing. For example, the battery manufacturing cost per kWh was around 1000$ in 2010 whereas is costs about 230$ currently. The forecast cost in 2030 is lower than 100$ per kWh[1], that would mean that it is less expensive to buy electric car rather than thermal cars for the same performance.

One negative aspect about electric vehicles is their charging time which can lasts more than a day for a for domestic plug. The car manufacturers are competing to reduce this amount of time by creating more powerful charging facilities. For example, Tesla released the Tesla Supercharger in 2012 which provides around DC of 140 kW. Tesla's CEO Elon Musk announced in 2017 a new kind of charger: the Megacharger[2] which will be used for the Tesla Semi, a concept of an electric truck. The power of this charging system was not announced yet but it is estimated to be at least 1 MW.

This following graph shows the battery charge rate of several levels of charging device. The most powerful (Supercharger) is able to fully charge the Tesla model S within 75mn which is relatively fast comparing to more conventional AC plugs but still far from just-in-time energy reception.

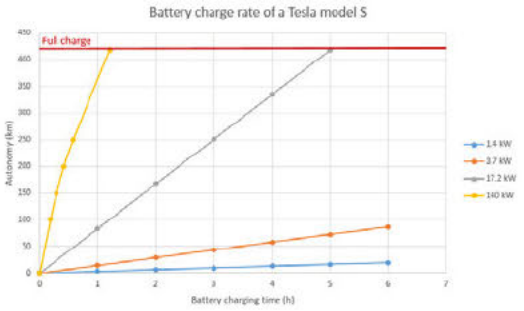

Fig. 1 . Battery charge rate of a Tesla model S

3 Future Technologies

Some cars and trucks manufacturers are looking for new technologies, which can provide a faster recharging, a longer cycle life and a reduced environmental impact. Among these technologies, one attract more attention : the solid-state battery. [3]

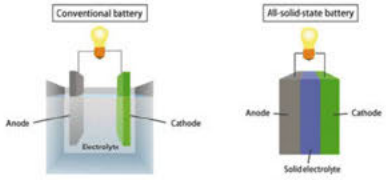

Fig. 2 . Comparison between Lithium battery and All-solid-state battery. Source : https://www.androidauthority.com/lithium-ion-vs-solid-state-battery-726142/

The solid state batteries work in the same way as every conventional battery, except that the electrolyte, namely the part which bond the anode with the cathode, is solid instead of being liquid.

This kind of battery is already used in several objects such as pacemakers, Radio-frequency Identification (RFID) or wearable devices because the lifespan of such a battery is estimated to be between 15 and 20 years [4]. Here is a table which summarize the main pros and cons of the solid-state battery [5]

Pros	Cons
Electrolyte nonflammable	Fragile / Bad choc resistance
Excellent thermal stability	Expensive manufacturing
Low self discharge	Fragile / Bad choc resistance
Long life cycle	
Non sensitive to overcharge	

The manufacturing of solid-state batteries is very expensive. Consequently, only small batteries are produced nowadays. It fits perfectly with every technology which require little power but a long lifetime. However, researches are currently made to increase the power of such a battery in order to include this kind of battery in electric cars.

One important point as well is that the battery charge is way faster compared to a Lithium one, due to its non-sensitivity to overcharge. As an example, the company *Fisker* works on a solid-state battery, which enable 700 miles ($\approx 1100km$) of range after one minute charging.[6]. This technology is expected between 2020 and 2023. *Toyota* also announced being working on solid-state batteries for its electrical vehicles. The company announced a fully charge within two or three minutes. Once more, the introduction of this technology into electric cars is expected in 2022.[7].

Finally, solid-state batteries has a higher energy density (up to twice more than a lithium battery) [8]. This means that the same amount of energy can be provided by a battery twice smaller, regarding the volume of this one. And this is a real pro as well, as far as transportation systems are concerned.

4 Vehicle propulsion Technologies

For the vehicle the energy carrier can be a fossil fuel or electricity which is generated by a battery.Depends on the energy carrier the vehicle propulsion systems are classified.The two main types of vehicle propulsion systems are electric propulsion systems and hybrid electric propulsion systems.

4.1 Electric propulsion systems

The electric propulsion systems are classified as Electric vehicles (EV'S) and Battery electric vehicles(BEV'S).Which means the drive train powered by battery.Since the energy density of the batteries does not permit driving autonomy , and the time required to refuel is not negligible compared to conventional vehicles.[9].

4.2 Hybrid electric propulsion systems

Keeping the advantages of an electric vehicles in mind, identifying the cons in terms of power and range, to boost up the power and range , by combining the electric propulsion system with the internal combustion engine, the requirements can be achieved and the combination is called the Hybrid electric vehicles.The Hybrid electric vehicles are classified into different types of configurations based on the systems.

4.2.1 Classification of HEV

Parallel hybrid electric vehicles will have two prime movers, so that it can operate on both Internal combustion engine and Battery either individually or simultaneously.

In series hybrids, only one energy carrier can be sourced at one time, cannot use simultaneously.

4.3 Some discussion about the future based on the past strategies

All the above are ongoing technologies, but not effectively.The problem lies in the fueling time difference and the range between the electric cars and conventional vehicles(Which runs with internal combustion engine). The outcome of ongoing research should benefit and meet the customer requirements as much as internal combustion engine do. As of now,(i.e, 2018) in terms of sustainability (zero emissions) the electrification technology is very much succeeded. Other than that, electrification technology did not match few measures as internal combustion engine do.There are so many concepts with the change in the battery technology are out,for example the new truck from Volvo called Volvo FL electric releasing in 2019 with 2-6 batteries can give a range of 300 kilometers with one charge, and battery should be recharged for 10 hours straight if it is alternative current and 1-2 hours with direct current[10].Still it makes a huge difference compared to fueling the car with gasoline or petrol. Here are some future concepts of just in time energy reception and discussion about how could this happen.The battery is the main source for the electric vehicles.

5 Conclusion

The progress has been seen from many years and welcomed the electric vehicle technology.But it has not reached up to the level in terms of cost and time for fueling if compared with the normal conventional vehicle since it is available readily and less cost.But the change over is required from normal vehicles to electric vehicles , because of environmental factors.For that mass marketing to reach and teach the people how it works, hope technological advancements and polices will change to create an ease for the transition.

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