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Electric Vehicles: Reality or Utopia? Theodoros Kosmanis

Electric Vehicles: Reality or Utopia? The status of electric vehicles in modern society is presented in this paper. From the very first appearance of electric vehicles in the 19th century to their present significant market share, their trip is briefly described. The advantages and the drawbacks of this •exotic† technology are analysed as a first step to the discovery of the electric vehicle place in modern society. Finally, a rational prediction of the future of the automobile market and particularly of the electric vehicle is attempted.

Key words : Electric vehicles, human powered vehicles, neighbourhood electric vehicles

INTRODUCTION

The advent of the electric vehicle dates back to the mid 19th century [3]-[6]. Stemming from the idea of replacing locomotion with a much more efficient, practical and clean technology, the electric vehicle was one of the Holy Grails of an era when industrial revolution gave motivation for scientists and inventors. It was Faraday's law around 1830 that set the physical background for the fabrication of electric motors and generators, two of the basic elements of an electric vehicle.

From the very beginning, the electric vehicle was the great competitor of the internal combustion engine one, as proved by the participations at the automotive exhibitions of that era. However, various factors have contributed in the supplanting of the electric vehicle from the early 1900s, the most important being the following [3], [6]:

- the appearance of the electric starter for the internal combustion engine that made the ICEVs more flexible and attractive to people,
- the very low quality of the batteries that were expensive, environmentally not friendly and could not provide the required energy and power density for pure electric vehicles

It was not before the late 1980s and early 1990s that the interest in electric vehicles re-appeared. Of course, nobody could claim that for almost a century there has been no interest about the electric vehicles. On one hand electric vehicles were constantly used in several cases like inside factories for merchandise transfer or as golf cars etc. On the other hand, the boost in power electronics technology allowed a more efficient control of electric motors and batteries. Also, the alarming increase of the environmental pollution and the crisis in petrol market, still in season, have turned a lot of researchers, organisations and industries towards scientific fields that are strongly related to electric vehicles. However, the great drawback of the electric vehicle technology was still there: the power source. Batteries or accumulators, traditionally used as the primary power source for electric vehicles were very far away from the advantages that the petrol as a fuel was offering to the ICEVs.

The official come back of the electric vehicle was made in September 1990 when the California Air Resources Board (CARB) declared the Zero Emission Vehicle (ZEV) Mandate, that forced automotive companies supplying the Californian market to produce a significant percentage of ZEVs [1], [8]. Since 1990, the automotive market has rapidly altered. Twenty years later, the market consists of the following commercial vehicle types:

- Internal Combustion Engine Vehicles (gasoline, diesel, alternative fuelled)
- Hybrid Electric Vehicles (series, parallel, mild)
- Electric Vehicles

During these twenty years, the efficiency and the performance of the electric vehicles has been significantly improved. Hybrid electric vehicles have simultaneously appeared commercially as a realistic combination between the ICEVs and the electric vehicles. This change in the market was based upon other technological products that were also introduced in it. Cellular phones, laptops and mobile devices in general base their operation on battery quality. This technology was introduced in electric vehicles and



together with the evolution in electromechanical systems, power electronics and informatics, allowed the electric vehicles to become commercial.

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ADVANTAGES OF THE ELECTRIC VEHICLE

Modern electric vehicles are, nowadays, competitive with the other types of commercial vehicles, ICEVs or HEVs [7]. The advantages of electricity have been revealed and thus they gain more and more share of the market. These advantages are summarized below.

The electric motors are much more efficient than the internal combustion ones. Their characteristics provide the flexibility to be placed in various locations inside the vehicle depending on the willing and the fantasy of the designer and the constructor. Thus, the strict and typical mechanical drivetrain of an ICEV can be replaced by other, advanced ones, where more than one electric motors may be used to provide propulsion. Four wheel drive (4WD) can be achieved easier, in-wheel motors are also a reality.

The overall drivetrain is significantly simplified due to the replacement of mechanical parts by electrical ones. Electric motors have their maximum torque at zero speed and they are also characterized by a wide speed range of constant power. The output control of an electric motor can be achieved by appropriate power electronic devices (controllers, inverters etc.) that are easily controlled and monitored by Electronic Control Units (ECUs) as illustrated in Fig. 1.

Since electric power is transferred by conductors and cables that are much easier to be handled and arranged in space, there is great design flexibility leading to smaller, much more futuristic but equally functional vehicle models.

However, the greatest advantage of the electric vehicle in an era of increased air pollution is bound with the zero emissions during its operation. This advantage renders the electric vehicle ideal for cities where there is large vehicle congestion. After all, this is what caused its reappearance in 1990.

(a)

(b)

Figure 1: Mitsubishi MiEV. (a) Side view, (b) Powertrain and control network.

DRAWBACKS OF THE ELECTRIC VEHICLE

Unfortunately, the electric vehicle comes along with two very important drawbacks that limit its commercial spread, the battery technology restrictions and battery charging (infrastructure and power production) [2], [8]. Powering the electric vehicle was setting and still sets the limit for the electric vehicle.

Although, vast steps have been made concerning battery technology, it is far below the case of providing an electric vehicle with range characteristics of a conventional ICEV. Batteries are still characterised by low energy density, keeping the autonomy of the vehicle low. Moreover, the charging time of an electric vehicle battery pack can in no way be



compared to the time a conventional vehicle requires for refuelling. 6-8 hours of charging are typical values for a reliable and safe charging of the battery. Fast charging can be achieved in less time but with higher electric currents. Even if charging and energy density problems of an electric vehicle could be overcome, batteries are still considered to be the most expensive, bulky and heavy components of the electrical vehicle powertrain. Such characteristics make the electric vehicle rather luxury product for someone to buy.

Moreover, there is another issue about the electric vehicle and that is related with the way the electric power to charge its battery pack is produced. The electric vehicle is considered to be a ZEV, however this is the case only during its operation, the tank-to-wheel (TTW). Taking into account the ways electricity is produced in various countries it is more than obvious that a well-to-tank (WTT) analysis reveals that the electric vehicle is not emissionless. Unless electricity is produced from renewable sources (solar energy, wind energy etc.), all widely used methods are not environmentally friendly. The Fukushima, Japan nuclear plant accident in 2011 is indicative.

WHAT ABOUT THE FUTURE?

It is obvious from the aforementioned advantages and disadvantages of electric vehicles, that the future of the pure electric vehicle is tightly bound with the future of the batteries, which actually constitute the only primary power sources. Despite the evolution of battery technology, it is unlikely that the electric vehicles will prevail over all other types of vehicles due to the cost in money and ecology of electricity production. Replacing all ICEVs with electric vehicles would mean in a rather extreme but not so unrealistic case that more than half the population of a country would charge an electric vehicle simultaneously. Will the power network stand such a demand? Of course not!

A more rational approach would be the effort to combine all existing vehicle technologies in an optimal way. For example, since electric vehicles are characterized by zero emissions during operation and low range, and often require a charge station, they would be ideal for a company owning a fleet moving inside a city (small city bus, delivery trucks, scooters or motorcycles). The charge station could be built at the company's private place where all vehicles would return after their shift and would be parked during the night. The city working cycle goes together with the requirements for low range. The profits would come from the zero emissions and the significantly reduced prices of electricity compared to the petrol ones. Moreover, in factories, airports and restricted areas where strictly zero emission vehicles must be used, the use of electric vehicles is one way. New types of vehicles appear, such as the human powered ones, that are small vehicles powered by electricity and the human power (something between bicycle and motorcycle). They are constantly entering the market and are considered ideal for individuals crossing small distances.

(a)

(b)

Figure 2: Modern electric vehicle designs. (a) Th!nk city, (b) Reva.



Of course, not the same tendency corresponding to the electric vehicles is followed by all countries. For example, the USA, Japan and some European countries promote the electric vehicle and already create the appropriate infrastructure (public chargers, special street lanes, legislation). The deployment of over 13,000 grid-connected vehicles and over 22,000 charging points in residential, commercial, and public locations in the USA by the end of 2013 is programmed [11]. A class of small electric vehicles, called neighborhood electric vehicles (NEVs) are becoming very popular (Fig. 4) [9]. Families living in the suburbs tend to owe an ICEV for long distance trips and an NEV to cover small distances for everyday activities.

In other developing countries, like those of northern Europe, although a research interest in electric vehicles exists, the way to a wide electric vehicle use seems to be longer. The main reason for this is the lack of infrastructure and possibly the price. That is why companies owning a fleet for cities can be the first targets. It is indicative that only at the beginning of 2011 were the first three electric vehicle charging stations built in Greece.

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CONCLUSIONS

Although the technological restrictions of current electric power sources are prohibitive for the prevail of electric vehicles in the automotive market, they cannot prevent them from playing a very important role in the future. Depending that they will be used in accordance with their advantages, it is certain that they can assist to the reduction of the air pollution and to transportation cost. It is ideal for city transportations, small distances

(a) (b)
Figure 3: (a) All-electric light commercial vehicle [15], (b) Human powered electric vehicle [13]

(a) (b)
Figure 4: Neighborhood electric vehicles available in the USA. [14]



(a) (b)

Figure 5: Electric vehicle charging stations. (a) in the USA [10], (b) in Greece [12].

and restricted areas. Having the appropriate support from the automotive industries and worldwide governments, the electric vehicle can gain its place in the future market of automobile.

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REFERENCES

- [1] Boschert S., Plug-in hybrids: the cars that will recharge America 2nd ed. New Society Publishers, 2007.
- [2] Dhameja S., Electric vehicle battery systems. Butterworth-Heinemann, 2002.
- [3] Ehsani M., Y. Gao, A. Emadi, Modern electric, hybrid electric and fuel cell vehicles: Fundamentals, theory and design 2nd ed. CRC Press, 2009.
- [4] Erjavec J., J. Arias, Hybrid, electric and fuel-cell vehicles. Thomson Delmar Learning, 2007.
- [5] Fuhs A., Hybrid Vehicles and the Future of Personal Transportation. CRC Press, 2009.
- [6] Husain I., Electric and hybrid vehicles. CRC Press, 2003.
- [7] K. Jost (editor), Global vehicles: Tokyo concepts, SAE Automotive Engineering International, pp. 16-32, December 2007.
- [8] Larminie J., J. Lowry, Electric vehicle technology. John Wiley & Sons, 2003.
- [9] Sperling D., Future drive: electric vehicle and sustainable transportation. Island Press, 1995.
- [10] <http://ceoworld.biz>
- [11] <http://www.ens-newswire.com/ens/may2011/2011-05-17-091.html>
- [12] <http://www.heliev.gr>
- [13] <http://www.ip-zev.gr>
- [14] <http://www.nevco-ev.com>
- [15] <http://www.smithelectricvehicles.com>

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