

# Hybrid Electric Vehicles: Status From Past to Present and Environmental Concerns

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**Abstract:** This paper gives a general overview of hybrid electric vehicles (HEVs). Fundamental costs and development within the area of HEV s are analyzed to show the role that this technology plays in the current automotive market. The advantages and disadvantages of this vehicle technology are also discussed in detail. The paper will also focus on the current and future market projections of HEVs; particularly on the legislative movements which are helping to increase the market share for environmentally friendly vehicles. Opinionsof researchers and automotive companies will be taken into account to predict which will be the leading technology trends in the future.

*Index Terms:* Electric vehicle, Battery, IC Engine, Petrol, Diesel.

## I. INTRODUCTION:

Hybrid electric technology has become the latest milestone for the automotive industry such have been diesel technology and the gear system in the past. The growing threat of globalwarming, excessive petrol dependence, ever increases prices of fuel, and driving trends are just a selection of reasons which have accelerated the development of Hybrid Electric Vehicles (HEV). Also, some government backinghas offered support to HEV technology with the introduction of restrictive legislation particularly concerned with the reduction of CO2 emissions. This paper aims to observe the initial basis of this incipient technology, analyze the current concepts, and discuss the future developments of HEV s by forecasting future events and market sales. Legislative enforcements, different configurations, the breakdown of components, and currently available hybrids will be analyzed and discussed in this report to illustrate the issues involved with HEV technology.

This publication has been broken down into many sections, with a range of areas being covered throughout. The history behind HEV s will be presented, providing a brief picture of the technology. A discussion of what HEVs are, in explaining the current HEV concepts will follow. The motivations behind the move towards this technology will be viewed; showing the reasons why this technology is beginning to grow in stature. The breakdown of hybrid-specific components will be mentioned, and the differences between these and conventional configurations will be compared. How HEVs work will be covered alongwith the operating features of HEV configurations. Current and future HEV models are a key area, and the market status is illustrated and tormented upon. There are comparative buying issues between HEV and diesel technologies, and these are analyzed and discussed in detail near the end of the work. The publication will conclude with a look at future trends and a summarization of the key ideas behind this ever-growing technology.

## II. HEV STORY:

The competition between vehicles powered by electricity and those powered by an internal combustion engine (ICE) is not a new scenario; this antagonism dates back to as early as the beginning of the 19th century. Between 1890 and 1905 ICEs, electric vehicles (EVs), and steam-powered cars were all marketed in the United Kingdom and the United States. EVs were the market leader in the United States at this time; mainly due to the works of electricity pioneers such as Edison and Tesla.

The limiting range of EVs was not a big problem as the roads linking the cities were not particularly adequate for vehicle transportation. It was evident that the use of batteries in automobiles was going to pose limitations in the range and utilityof EVs. Due to the energy advantages of petrol-powered vehicles over battery operation, petrol became the dominant energy source over the next 100 years and is still leading the way today. At the time many automotive companies designed direct ICE vehicles, but some tried to combine theadvantages of the electric vehicle with those of an ICE vehicle by creating a hybrid of the two. The first ever HEV was built in 1898, and several automotive companies were selling HEVs in the early 1900s. The production of HEV s did not last the course of time due to significant problems with them. Henry Ford initiated the mass production of combustion engine vehicles; making them widely available and affordable within the \$455to \$911 price range (375€ to 750€ with prices taken from the current American dollar to Euro conversion rate). In contrast, the price of the less efficient EV s continued to rise. In1912, an electric roadster sold for \$1,732 (1,425€), whilst a gasoline car sold for \$547 (450€) as illustrated by About Inventors. Another problem was the requirement for smooth coordination between the engine and the motor, which was not possible due to the use of only mechanical controls.

Since these early attempts, there has been a rise in the concern for global warming, a continual rise in fuel prices, and the threat of oil reserves drying up altogether. This had led to an interest in more efficient and environmental means of transport again, particularly in the area of HEV. With advances in battery technologies and onboard computer systems, the option of a plausible

HEV has become reality, and several models from the likes of Honda There have been several prospective designs and HEV have been growing ever since their inclusion of them in the world market in 2000. The increased interest along with legislative movements has made advanced clean and efficient transportation not only a vision for the future but one for today. For this work, the definition of an HEV will be as follows: A Hybrid Electric Vehicle (HEV) is powered by two or more energy sources, one of which is an electrical source. The two most common sources of power in an HEV are mechanical (ICE) and electrical (from batteries). The addition of an electric motor in an HEV means that the size of the gasoline engine can be reduced. The gasoline engine in a hybrid is made to within the specification of the average power requirements of the vehicle, rather than the peak power, this is because the electric motor can provide full operation at low speeds and acceleration assist when an extra boost of energy is required (high accelerations or climbing steep inclinations).

The combination of the set of power sources means that the vehicle has the rapid refueling characteristics of an ICE and the energy-saving capabilities of an EV. The onboard electronics on an HEV can determine whether the gasoline engine, the electric motor, or even both are the most efficient means of use at any given time. In a parallel configured HEV this operation is evident, where both the ICE and the electric motor can provide propulsion power to the transmission. A series-configured hybrid differs slightly as the ICE never directly powers the vehicle. HEVs do not need to be plugged into an external source as all recharging is done whilst the vehicle is in operation. The electric motor acts as a generator through the process of regenerative braking to recharge the batteries with the energy which would once have been lost through heat and frictional dissipation. Regenerative braking occurs whilst the vehicle is slowing down or during idle conditions, such as at traffic lights or junctions. Through the combination of both the direct drive from the engine and the recaptured energy through regenerative braking, the energy stored within the batteries will be sufficient amount for the vehicle to operate.

### III. PETROL DEPENDENCY:

#### III.1 Resource Supply:

The reality that petrol is a finite natural resource is often talked about and commonly overlooked. It is an area that needs to be addressed sooner rather than later to shape the future better in terms of moving away from our dependence on this natural resource. There have even been predictions into the forecasts of when this resource will eventually run out. Hubbert has established himself as a famous analyst due to his successful predictions during his career; one occurrence he rightly determined was the peaking production of American oil in 1978. He has proven that he has superior knowledge due to the successful outcomes of his theories.

Hubbert has also predicted that in 2019, global oil production will have fallen by 90% of current rates [1]. This could well be the situation we are heading for as all of Hubbert's models and theories to date have been correct. Also, one of the biggest shifts in recent times has been the increase in the price of fuel. Since 2001 crude oil prices have doubled. With the rising uncertainty in the Middle East, it is becoming more of an issue to be less reliant on supplies from this oil stronghold. In contrast to this, the quick development of both China and India has provoked an increasing demand for crude oil. It can be seen that it is possible to compare the newly discovered oil (primarily in Saudi Arabia and Russia) is struggling to match the increase in demand, particularly; where demand will far out way supply. It is becoming imperative to move towards a more efficient means of technology within the automotive industry, to keep all these dependencies and costs discussed here to a minimum.

#### III.2 Transportation Issues:

Away from the on-road effect oil has on vehicles, there is the issue of the safe transportation of oil from overseas. At 3.15 pm on the 13th of November 2002, the single-hulled oil tanker Prestige loaded with 77,000 tons of residual heavy fuel oil, sent out an SOS message at a distance of 28 miles from Finisterre, Spain. It was then at 5 pm that the first liters of crude oil began to pollute the Atlantic Ocean [3]. Since this disaster little has changed in legal terms surrounding this issue. The European Union has however forbidden the entry of single-hulled ships carrying heavy fuel into European ports. This type of fuel represents only 5% of all the oil products which enter Europe. Even with these minor efforts in place, the International Maritime Organization (IMO) has already begun to criticize these timid initiatives. European coastlines have never before seen the catastrophe which led to over 2000 kilometers of coastline being affected by the oil slick. Hundreds upon thousands of birds were covered in oil, and even to this date oil is still reaching the shores of our European coastlines. To prevent such occurrences from happening again, the dependency and thus mass transportation of oil must be reduced. The Prestige disaster must serve as a constructive lesson to lead and change the direction of fuel dependence and transportation.

The technology of HEVs will lessen the dependency on fuel, and reduce the extent of this risk from happening again. It cannot be guaranteed that such an occurrence will ever happen again, despite the reduced amounts of oil being shipped, however tighter control methods will ensure that such events would be very unlikely to cause any serious effects to the level of the Prestige disaster.

### IV. ENVIRONMENTAL CONCERNS:

#### IV.1 Driving Trends:

Driving habits have changed a tremendous amount over the last number of years. According to an EU report, on average each European citizen travels thirty-one kilometers every day by car. This figure has grown substantially over the last number of years, from 23.5 km/day between 1991 and 2001, and 16.6 km/day between 1985 and 1986 [4]. According to the same report, the average number of occupants per vehicle is a lowly 1.3 passengers. In the early 1970s, this figure was between 2.0-2.1, falling to 1.5-1.6

during the early 1990s. This decrease over time is a result of increasing car ownership, extended use of cars for commuting, and a continued decline in the size of households. The average speed for example in Baree/Ona is a mere 13km/h. In such crowded conditions, HEVs would work effectively within this environment. By taking advantage of electric-only drive, and the recapture of energy through regenerative braking, these necessary factors would deem the mass inclusion of HEVs a successful venture. One quote regarding driving trends and particularly the usage of vehicles is during 2,000 hours of usage of Ola vehicles in Paris, the average time the vehicle is at a complete stop is 700 hours.

#### IV.2 Global Warming:

The Growing effect of global warming is being made worse by CO<sub>2</sub> emissions from vehicles. CO<sub>2</sub> is the primary greenhouse gas which increases the global temperature. The emissions of CO<sub>2</sub> from vehicles are a huge concern, and there have been several research efforts that have gone on to fully begin to understand the full extent of the problem [4], [6]. As an example, the emissions of CO<sub>2</sub> from vehicle transport represent 48% of the overall amount of CO<sub>2</sub> produced in the whole of Spain. These scary figures need to be controlled to preserve the environmental safety of Spain and the rest of the world. Increased global warming concerns have coincided with the growing interest in HEVs, and the development of improved battery technologies and integration enhancement. Developments of these sophisticated computer systems will offer greater efficiency benefits whilst providing smooth coordination between the two propulsion systems. Advanced batteries such as nickel-metal hydride (NiMH) can now provide much higher energy densities and longer cycle life. These features when used within an HEV can significantly reduce emissions of CO<sub>2</sub>.

#### IV.3 Emission Legislation:

Emissions legislation developments are becoming a motivational development for the technology of HEVs [9]. It has become necessary to create a future regulatory plan to warrant a suitably clean world to live in. The Kyoto protocol is one of the main agreements which have been agreed upon by the majority of the countries in the world. The pact requires that industrialized countries must reduce their greenhouse gas emissions to 8% of those levels during the 1990s, between the years 2008 and 2012 [10]. There have been differing approaches in the EU, the US, and Japan for the regulation of emission laws. The greatest change has been registered in the diesel segment due to the major pollution comparisons that this has with gasoline engines. The further development of strict standards in the US must take into account that the diesel market share only represents 1 to 2% of the total number of vehicles sold, with the majority being imported from Europe by a manufacturer such as Volkswagen. Europe has an established tradition behind diesel technology, and it is not possible to follow the same approach regarding emissions regulations as has been done in the US. In Europe, targets have been set to lower the limits of CO<sub>2</sub> emissions to 140g/Km by 2008, and reduce these still further to 120g/Km by 2012. The current average levels of CO<sub>2</sub> emissions stand at 162 g/km it can be observed that emission legislation is becoming more and more focused on improving the environmental state of the automotive industry. The adoption of increasingly stringent laws will enable these targets to be met, and help to maintain the healthy state of the planet.

#### IV.4 Health Effects:

Several health complaints can be caused by emissions from vehicles. Respiratory problems increase a person's risk of cancer-related death, and can also contribute to birth defects or make healthy active children 3 to 4 times more likely to suffer from asthma. These are just a selection of problems that can stem from the pollution from vehicles, particularly CO<sub>2</sub> emissions. Even experts have forecasted many new diseases provoked by the high concentration of CO<sub>2</sub>.

### V. CONCLUSION:

In conclusion, it can be seen that the continual rise in fuel prices during the nineties along with the tax advantage of types of diesel has had a significant effect on the sales of diesel vehicles, especially in the EU. However, on a wider scale, it is becoming more evident that global warming and vehicle pollution are factors that need to be controlled better. These concerns have to date provoked the introduction of more hardened emission legislative laws, especially for diesel vehicles. To have a lesser dependency on the increased price of fuel and to operate a more environmentally friendly vehicle the technology of HEVs would more than help to satisfy these requirements.

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