

# Advantages and disadvantages of hybrid vehicles engineering essay



Hybrid Electric Vehicles (HEV) entered US market in the end of 20th century and during the last years have been highly developed and they succeeded entering the European market. [3] The purpose of this report is to analyze the advantages and disadvantages of HEV compared to conventional and electric vehicles.

## **Hybrid Electric Vehicles – Overview**

Hybrids are a combination of conventional and electric vehicles. They can have an internal combustion engine, a fuel cell or a gas turbine as power source, an electric motor, a regenerative braking system, a power inverter/motor controller, hybrid system controls and a battery. [4] [3] [5] There are four types of HEV: series, parallel, series-parallel and complex hybrid. [2] In this report hybrid vehicles are considered to be the HEVs with an ICE, the conventional vehicles are the typical internal combustion engine vehicles (ICEV) and electric vehicles are considered to be the battery electric vehicles (BEV).

## **Advantages and Disadvantages of HEV**

HEV have many advantages in comparison to ICEV and BEV but as they are still an emerging technology they do have some disadvantages. This report will present the advantages and disadvantages of HEV in three areas: cost, efficiency and performance, and environmental impacts.

267

### **Cost**

Typically HEVs have a higher retail price than CV but a lower one than EV. A typical retail price of a Honda Civic (ICEV) in USA is \$18, 655, of a Toyota <https://assignbuster.com/advantages-and-disadvantages-of-hybrid-vehicles-engineering-essay/>

Prius (HEV) \$22, 000 and of a Chevrolet Volt (EV) \$40, 000. (Mitchell) It is estimated that a consumer needs about 8 years to breakeven the bought of a HEV instead of a CV and 39 years to breakeven buying a BEV instead of a HEV and that gives ICEV advantages over the alternative technologies. [6]

The Total Ownership Cost (TOC) over a 10-year period (life-time period that includes maintenance and operation costs) gives HEV an advantage. For instance, a parallel HEV has the lowest net present value, about \$69, 000, an ICEV about \$71, 000 and a BEV about \$80, 000, under certain financial parameters. [7] Usually HEV have higher maintenance and insurance costs and higher batter costs per kilometer but they have much lower fuel costs. [3] The main reason that HEV has an advantage against BEV is the high cost of battery for the latter. [8] [2] [9] A typical ICEV has a fuel consumption of 4. 2 l/100km and 6. 2 l/100km for diesel and gasoline respectively, a HEV 3. 8 l/100km and a BEV 0 l/100km. The average fuel prices for EU are 1. 35 and 1. 48 € for diesel and gasoline respectively and the average EU electricity price is 0. 16 €/kWh. [10] During the life-cycle a conventional car will change the battery once for 100\$, a HEV for \$1020 and a BEV needs to change it twice with total cost of \$30, 800. [8]

255

## **Efficiency and Performance**

In European Union (EU 27) transportation sector consumes 37% of total energy, where 85% of this comes from road transportation. [1] In general the HEV has an advantage over ICEV in all stages of energy usage: during energy generation (wheel-to-tank, WTT), during operation (tank-to-wheel,

TTW) and on a full fuel cycle (well-to-wheels, WTW). On the other hand, BEV has an advantage over HEV in TTW and WTW stages but uses more energy in WTT stage for the electricity generation. A typical HEV has lower specific fuel consumption than an ICEV and higher than a BEV. A HEV has lower energy annual cost than an ICEV but higher than a BEV. Also, HEVs have bigger driving range than ICEVs and BEVs. [8] [1] [11] Regarding the energy conversion efficiency (energy consumed at the wheels divided by total energy supplied to the vehicle) a HEV has higher conversion efficiency than an ICEV but lower than a BEV. [12] [2] But, in a well-to-wheel analysis a HEV could have higher conversion efficiency from BEV too depending on the electricity generation source. From a consumers point of view an HEV has lower top speed than an ICEV but bigger than a BEV. Moreover, a HEV can have higher acceleration than both ICEV and BEV. [2] Typical values of the efficiency and performance of vehicles with different technologies are presented in Table .

The main reasons for the advantages of HEV in comparison to the ICEV are the lower engine size, the use of regenerative braking energy and the ability to operate only in battery when is available. [13] [14] [5]

260

## **Table**

Efficiencies and performance of each vehicle technology. (Source: ref. [2])

Conventional

Hybrid

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BEV

Reference car

VW Golf 1. 4TSI

Toyota Prius III

Nissan Leaf

Top speed (km)

200

180

161

Acceleration (s)

9. 5

10. 4

7

Range (km)

888

1152

117-175

Net Power (kW)

90

100

80

Effective Storage capacity

(kWh usable)

105

143. 1

22. 1

Average conversion efficiency (%)

21

35

92

## **Environmental Impacts**

Transportation sector accounts for about 19% of the total CO<sub>2</sub> emissions and road transportation is responsible for 94% of this amount. HEV have an advantage over ICEV as they produce lower CO<sub>2</sub> emissions, which is the main greenhouse gas, during the driving stage (TTW). As far as BEVs are concerned, they have zero emissions in TTW stage. [1] [16]

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Regarding the total GHG emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O and SF<sub>6</sub>) and the total air pollutants emissions (AP: CO, NO<sub>x</sub>, SO<sub>x</sub> and VOCs) HEVs have lower GHG emissions in all stages (WTT, TTW and WTW) than ICEVs, but regarding BEVs the emissions produced in WTT and WTW stages are depending on electricity generation mixture and that could lead to high variations. [8] [15] At the production stages of a vehicle, a HEV has higher GHG and AP emissions than an ICEV but lower than a BEV one. That is due to the high environmental impact for the production of batteries. At the fuel utilization stage and during the total environmental impact (assuming 10 years lifecycle and that a car drives 241, 350km) a HEV has lower GHG and AP emissions than an ICEV. For the BEV emissions there are variations because of the electricity production. Under three scenarios for electricity generation: (1) electricity from renewable energy sources (RES) and nuclear energy; (2) 50% from RES and 50% from natural gas with efficiency of 40%; (3) all electricity from natural gas with 40% efficiency a BEV will have lower emissions at both, fuel utilization and total environmental impact, than a HEV. [8] [17] Typical values of GHG and AP emissions for each type of vehicle are presented in Table .

Table

Emissions for each type of vehicle during production and utilization stages  
(source ref. [8])

Vehicle Production

(kg)

Production of NiMeH battery (emissions per life of vehicle, kg)

Fuel utilization usage

(kg per 100km of vehicle travel)

Total environment impact

(kg per 100km of vehicle travel)

GHG

AP

GHG

AP

GHG

AP

GHG

Conventional

3595.8

8.74

—

—

19.9



0. 0564

21. 4

Hybrid

4156. 7

10. 10

89. 37

0. 507

11. 6

0. 0328

13. 3

Electric

4758. 3

15. 09

1087. 6

6. 167

1a

0. 343

0. 00131

2. 31

2

5. 21

0. 0199

7. 18

3

10. 1

0. 0385

12. 0

a Numbers in this column refer to the electricity production scenarios.

Moreover, Hawkins et al. [18] compared the total lifecycle Global Warming Potential (GWP) for vehicles of each technology and the results show the advantages of HEVs over ICEVs and the high variations of BEVs, and those can be seen in Fig. 1.

Fig. . Comparison of lifecycle global warming potential per km driven.

(source: ref. [18])

314

## **Conclusions**

In conclusion, HEVs have many advantages over ICEVs and can also compete with BEVs because of the high price for latters. They have good energy efficiency and high performance and can compete with both, ICEVs and BEVs. In terms of environmental impacts, in lifecycle they have significant lower emissions than ICEVs and in some cases against BEVs too as those are depending on electricity generation mixture. Despite their high initial price HEVs are considered to be a very good choice today and it is estimated that in the next few years their percentage in the car market will get higher. As BEV are still in their early stages for being fully developed and enter the market in competitive terms HEV can be the bridge to the future road transport.

(129) (1225 total)