

REDUCING GAS EMISSIONS FROM TRANSPORT BY INTRODUCING HYBRID ELECTRIC VEHICLES

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ABSTRACT

The work presents one of the most serious problems related to air pollution as it can have effects both in the short term, but especially in the medium and long term. By increasing the number of automobiles put into circulation every year, in addition to the increase in fuel consumption, the problem of pollution has been accentuated, due to the noxious emissions of the internal combustion engines used for their propulsion. The requirement to reduce fuel consumption has become even more acute as it is closely related to environmental pollution.

KEYWORDS: hybrid electric vehicles, fuel consumption, CO₂ emissions, environmental pollution, plug-in hybrids

1. Introduction

Through the Kyoto Protocol, developed countries committed to reduce greenhouse gas emissions in the period 2008-2012 by approximately 5% compared to 1990 levels.

Hybrid vehicles manage to reduce the consumption of conventional fuel by using the electricity they produce while driving. Although the consumption is lower, the basis of the propulsion of hybrid cars is still a fossil fuel - a non-renewable resource that is running out [3].

Transport was the source of around a quarter of all EU CO₂ emissions in 2019. Of these, 71.7% came from road transport, according to a report by the European Environment Agency.

The new Framework Directive (Directive 2007/46/EC1) extends the legislative framework for the type approval of motor vehicles, including all types of vehicles, regardless of the propulsion systems used.

The new Framework Directive also includes hybrid electric vehicles and electric vehicles [4].

Directive 2009/33/CE of the European parliament and of the council of 23 April 2009 requires contracting authorities, contracting entities, as well as certain operators to take into account the energy and environmental impact during the lifetime, including energy consumption, CO₂ emissions and of certain pollutants, when purchasing road transport vehicles, with the objectives of promoting and stimulating the market of non-polluting and energy-

efficient vehicles and improving the contribution of the transport sector to Community policies in the field of environment, climate and energy [5].

Directive 2010/31/EU states that states must establish requirements for the installation of a minimum number of recharging points for electric vehicles for all non-residential buildings with more than twenty parking spaces by 1 January 2025 [6].

Electric power has the potential to increase the energy efficiency of road vehicles and contribute to a reduction in CO₂ in transport. This is a source of energy indispensable for the introduction of electric vehicles.

The number of recharging points should be set by taking into account the number of electric vehicles expected to be registered by the end of 2020 in each Member State [7].

According to the data provider, APIA, interest in "green" cars (electric and hybrid) continues to remain high this year. In 2018, they held a 2.5% share of the total market. Even if the volumes are still very small, the evolution is extremely encouraging, the increase recorded this year being 225.5% in the electric segment (485 units, in the first 7 months of 2018, compared to only 149 in 2017), respectively +54.5% for hybrids (1,754 units in 2018, compared to 1,135 units in 2017), which proves that there is an increased interest in this category of cars [8].

The European Commission EU 2020 strategy includes the green car initiative "European Green Cars Initiative (EGCI); which consists of a series of measures to support research and innovation in order to create a new generation of cars, trucks and buses,

which will protect the environment and create new jobs and a competitive industry.

Harmonization of regulations for car construction is very important [9].

The European Commission's EU 2020 strategy includes the green car initiative "European Green Cars Initiative (EGCI)", which consists of a series of measures to support research and innovation in order to create a new generation of cars, trucks and buses that protect the environment and create new jobs and a competitive industry. In the Multiannual Strategic Plan of the ENIAC platform of the European Commission, two emergencies "full electric car" and "safe car" are included.

In this sense, two E3Car projects were launched in 2009 – Nanoelectronics for an energy efficient electric car and SE2A – Nanoelectronics for Safe, Fuel Efficient and Environment Friendly Automotive Solutions [10].

In order to ensure that hybrid vehicles comply with the noise limits set out in Directive 97/24/EC in all operating modes, it is also necessary to adapt the type approval test procedure used to measure the noise in Directive 97/24/CE [11].

In Romania, according to the statistics provided by the Association of Automobile Manufacturers and Importers (APIA), based on the statistics of the Motor Vehicle Registration and Driving License Regime Directorate (DRPCIV), in the first 10 months of 2021, "electrified" cars, respectively electric ones (100% and plug hybrids – in which they are charged from an external source), as well as full hybrids (cars that also have electric propulsion without charging from the source) have reached a market share of almost 13%, higher about 2 times compared to the previous period in 2020. In November 2021, a market share of 14.2% was already recorded, which is 2.1 times higher than the one they had in the same period last year (6.7%) [12].

The European Union wants at least 30 million vehicles with zero emissions to circulate on its roads by 2030, in order to reduce the consumption of fossil fuels in the member countries. "The EU's goal of zero greenhouse gas emissions by 2050 cannot be achieved without the introduction of extremely ambitious measures to reduce the transport sector's dependence on fossil fuels." Sales of hybrid and electric cars in the European Union and Great Britain reached 458,915 units last year, up 110% compared to 2017 [13].

Car sales in Europe will see a considerable increase for cars equipped with innovative systems that protect the surrounding nature.

2. Hybrid electric vehicles

The use of oil as the sole source of energy for passenger vehicles has led to economic and political crises that have been amplified as the world's oil reserves have dwindled. By increasing the number of cars put into circulation every year, in addition to the increase in fuel consumption, the problem of pollution has increased, due to the emissions of internal combustion engines used for their propulsion.

The development of the car was closely related to the reduction of fuel consumption and the adaptation of the propulsion system to operation with other types of fuels.

The requirement to reduce fuel consumption has become even more acute since it is closely related to environmental pollution.

An alternative would be the use of electric vehicles, the number of which is still not significant.

"Hybrid electric vehicle (HEV) means a vehicle that, in order to ensure its mechanical propulsion, takes energy from the following two stored energy sources on board: a fuel; an electrical energy storage device (e.g., battery, capacitor, flywheel/generator etc.

Electric and electric hybrid cars are superior to conventional ones both in terms of energy conversion efficiency and harmful emissions.

Electric motors offer a range of benefits from reduced emissions while driving, to lower running costs, to more responsive acceleration at start-up.

The main elements of hybrid electric vehicles are the electric motor and the thermal engine, the electric energy source and/or the electric energy storage system, the transmission, the power electronics and the command-and-control systems that ensure the operation of the vehicles as a whole.

Electrified engines are more expensive than gasoline or diesel engines.

Regenerative braking is common in hybrid vehicles. The energy created by the vehicle when braking is saved in the battery. This energy can then be used to power the electric motor or other electricity consuming components [18].

The Electric Vehicles Initiative (EVI) is a forum for global cooperation on the development and deployment of electric vehicles [19].

Charging times vary and depend on factors such as outside temperature, current battery temperature, charging equipment, battery condition, and vehicle condition.

It is predicted that by 2030 there will be no new car without at least one electric motor or without benefiting from a hybrid system. Both electric cars and electric hybrids are criticized for their lack of autonomy [2].

The issue of justifying an autonomy comparable to that offered by fossil fuels is raised.

There are solutions that increase the range when needed, such as the "Range Extender" mode.

Plug-in hybrid vehicles (PHEVs) face an uncertain future if the EU reclassifies how CO₂ emissions are measured. If emissions double, owners will pay higher taxes and switch to electric cars.

2.1. Evolution of CO₂ emissions

The European Union is set to impose a new CO₂ directive on hybrid cars (PHEVs), which could have a dramatic impact on their success and accelerate the adoption of electric vehicles.

All PHEVs are likely to have their official emissions figures – measured in grams per kilometre

of CO₂ (g/km) – more than double by 2027 under the new EU6 regulations.

A hybrid car works on the basis of two sources of power, a gasoline engine and an electric one. This system has the possibility to recover energy through regenerative braking.

When the car is idling, the number of emissions released into the atmosphere is much higher. However, most drivers believe that stopping and restarting the engine consumes more fuel than idling. This is not true unless the car has been idling for less than a minute. The pollution produced by a car is greater if we also turn on the air conditioning system. This does not mean, however, that we should not benefit from the existence of this system.

Figure 1 shows the evolution of CO₂ emissions in the European Union from 1990 to 2019.

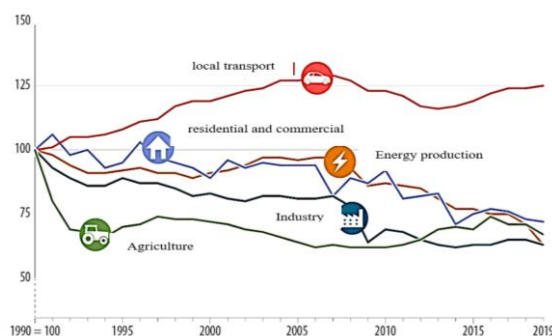


Fig. 1. Evolution of CO₂ emissions in the EU (1990-2019) [16]

The advantages of hybrid propulsion systems are: zero local emissions (electric car); reduced fuel consumption/reduced CO₂ emission due to: recovery of braking energy; start / stop operation; moving the engine operating regimes towards the economic pole, reducing the cylinder capacity through electric assistance [14].

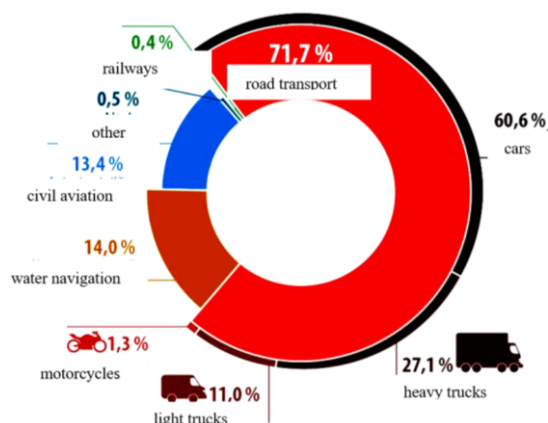


Fig. 2. Emissions by transport mode Source: European Environment Agency 2022 [16]

Figure 2 shows gas emissions from transport (2019). Private cars pollute the most, emitting 60.6% of all CO₂ emissions from European road transport [16].

There are two ways to reduce CO₂ emissions in cars: making them more efficient or changing the fuel. In 2019, most road transport in Europe used diesel (66.7%), followed by petrol (24.55%).

Electric cars are gaining ground though. They accounted for 11% of all new vehicle registrations in 2020.

Sales of electric vehicles (full electric or plug-in hybrid) have grown massively since 2017 and tripled in 2020 when the current CO₂ targets came into effect.

Electric vans accounted for 2.3% of the newly registered van market in 2020.

Most people charge their cars at home overnight using a charging wall box. Others have the option of charging their car at work or at public charging stations, which in many areas are becoming easier to find.

The production of an electric car is less environmentally friendly than an internal combustion engine car, and the level of emissions from electric

vehicles varies depending on how the electricity is produced.

One of the major problems we are currently facing is the problem of pollution. Emissions during the driving of vehicles play an important role in atmospheric pollution.

Transport was the source of around a quarter of all EU CO₂ emissions in 2019. Of these, 71.7% came

from road transport, according to a report by the European Environment Agency.

The state will have to provide the necessary infrastructure for charging stations for electric vehicles and in apartment buildings, both new and those undergoing major renovations, and which have more than ten parking spaces.

Figure 3 shows the evolution of CO₂ emissions from new vehicles.

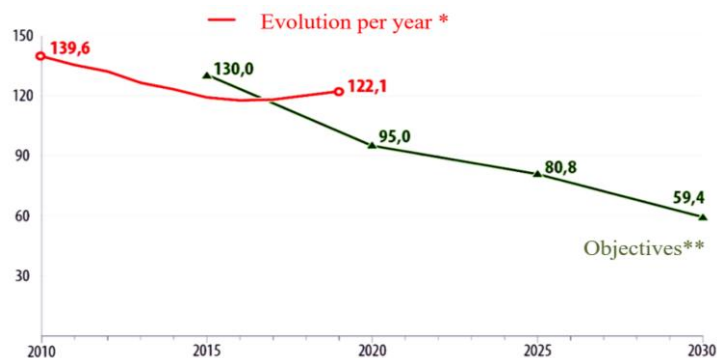


Fig. 3. The evolution of CO₂ emissions from new vehicles (g CO₂/km) [16]

*Estimated for 2010, 2011 and 2012

**Indicative objectives calculated by the European Environment Agency (EEA) according to regulation (EU) 2019/63.

Hybrid electric vehicles can be propelled either only by the internal combustion engine, or by the electric one or more, or by all at the same time.

Mild hybrid vehicles are efficient at low speeds. Mild hybrid vehicles suit the urban lifestyle: short trips in the city at relatively low speeds.

The accumulators of a mild hybrid can be charged exclusively with the help of its own systems, that is, the energy sources on board are used. These vehicles cannot be powered by the electric motor alone. Compared to plug-in hybrids, mild hybrid vehicles have smaller motors/generators and smaller capacity batteries, which is reflected in price and performance.

Hybrid electric vehicles have a greater autonomy than mild hybrids, they are intended for longer roads and high speeds.

Electric cars are at least twice as clean as internal combustion ones.

We have to consider four elements: the impact during production, the impact at street level, the energy consumption per hundred kilometres, the sources from which this energy is produced.

According to a study by the Union of Concerned Scientists, the production of an electric car is 15% to 68% more polluting, in terms of CO₂ emissions, than the production of a normal car.

This difference in CO₂ emissions cancels out after several tens of thousands of kilometres of driving an electric car, usually in the first 5 years of use.

Advantages of hybrid cars: hybrid cars must be powered only with fuel (not electricity); the electric current they use is produced while running, by the combustion engine and also from the braking energy; when you apply the brake, the battery is supplied with electricity; hybrid cars do not require a special infrastructure (special fuelling stations) being able to be used wherever there are regular petrol pumps; the cars are very quiet.

Disadvantages of hybrid cars: hybrid cars do not solve the problem of using fossil fuels, they are still based on gasoline, thus contributing to the depletion of these non-renewable resources; they are more expensive.

Designing and building this type of vehicle is more expensive for manufacturers. Although the initial cost is high, a return is achieved over time due to reduced fuel consumption and reduced maintenance.

Autonomy can be a problem if we compare it to that of traditional ones.

Maintenance has a higher cost and cannot be performed in all workshops.

3. Conclusions

One of the major problems we are currently facing is the problem of pollution. Emissions during

the driving of vehicles play an important role in atmospheric pollution.

Transport was the source of around a quarter of all EU CO₂ emissions in 2019 (71.7% came from road transport, according to a report by the European Environment Agency).

Reducing CO₂ emissions is important because this gas is part of the category of those that during 2021, the European Commission proposed to reduce the emissions limit for cars and vans by a further 15% from 2025, followed by a 55% reduction for cars and 50% for vans from 2030, and to reach zero emissions by 2035.

Private cars pollute the most, emitting 60.7% of all CO₂ emissions from European transport.

Sales of hybrid and electric cars have increased thanks to tougher new emissions standards.

The global trend is to reduce the pollution generated by classic engines, with internal combustion, which is why most governments encourage drivers to reorient themselves to those that emit as low a level of emissions as possible.

Electric vehicles are already proving to be cleaner than gasoline-powered vehicles. As the share of electricity from renewable sources will increase in the future, electric cars will become even less harmful to the environment.

Electric vehicles would greatly reduce the major causes of smog, substantially eliminate ozone depletion and reduce greenhouse gases. With stricter standards on power plant SO₂ emissions, electric vehicles would have a reduced impact on SO₂ levels.

The major impediments to the widespread acceptance of electric vehicles by the general public are their limited range and lack of infrastructure. The solution to the autonomy problem may come in extensive research and development efforts in batteries, fuel cells and other alternative energy storage devices. An alternative approach is to make people aware of the problem of global warming and the advantages of electric vehicles.

References

[1]. Joldoş C., Şmadici O.-V., *Hybrid propulsion systems an efficient solution for on-board auto vehicle energy*, A XI-a Conferinta Natioanala multidisciplinara-cu participare

international, "Profesorul Dorin Pavel-fondatorul hidroenergeticii romanesti", Sebes, 2011.

[2]. Croitorescu V., Negruş E., *Cerinţe şi reglementări impuse automobilelor hibride electrice*, Lucrările celei de-a VII-a ediţii a Conferinţei anuale a ASTR, Universitatea "Politehnica" din Bucureşti, 2019.

[3]. ***, <https://www.colegiulasachi.ro/pdf-uri/Prezentare%20motorizare%20hibrid.pdf>.

[4]. ***, http://anap.gov.ro/web/wp-content/uploads/2021/07/Comunicarea-COM-2020_C352_01_Directiva-vehicule-curate.pdf.

[5]. ***, <http://data.europa.eu/eli/dir/2009/33/oj>, Directive 2009/33/EC of the European parliament and of the council of 23 April 2009 on the promotion of non-polluting and energy-efficient road transport vehicles.

[6]. ***, Directive 2010/31/EU of the European parliament and of the council of 19 May 2010 on the energy performance of building.

[7]. ***, Directive 2014/94/UE a parlamentului European şi a consiliului din 22 octombrie 2014 privind instalarea infrastructurii pentru combustibili alternativi.

[8]. ***, <https://www.gov.ro/ro/print?modul=subpagina&link=nota-de-fundamentare-oug-nr-17-19-03-2019#null>.

[9]. ***, <https://eur-lex.europa.eu/legal-content/RO/TXT/PDF/?uri=CELEX:52012AE2487&from=LV>.

[10]. ***, <https://www.agir.ro/buletine/2079.pdf>.

[11]. ***, <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:213:0010:0025:RO:PDF>.

[12]. ***, <https://ziare.com/auto/masini-electrice/top-10-cele-mai-vandute-ma-ini-electrice-i-hibride-in-romania-decembrie-2021-1715232>.

[13]. ***, <https://www.digi24.ro/stiri/externe/ue/ue-vrea-ca-30-de-milioane-de-masini-cu-zero-emisii-sa-circule-in-europa-pana-in-2030-1412334>.

[14]. ***, <http://www.gomexpert.ro/satunare/top-stiri/97-sistem-de-propulsie-hibrid-termic-electric>.

[15]. ***, <https://www.europarl.europa.eu/news/ro/headlines/society/20190313STO31218/emisiile-de-co2-de-la-autovehicule-date-si-cifre-infografic>.

[16]. ***, [https://www.europarl.europa.eu/news/ro/headlines/society/20190313STO31218/emisiile-de-co2-de-la-autovehicule-date-si-cifre-infografic-Emissiile de CO2 de la autovehicule: date şi cifre \(infografic\)](https://www.europarl.europa.eu/news/ro/headlines/society/20190313STO31218/emisiile-de-co2-de-la-autovehicule-date-si-cifre-infografic-Emissiile de CO2 de la autovehicule: date şi cifre (infografic)).

[17]. ***, <https://www.europarl.europa.eu/news/ro/headlines/society/20190313STO31218/emisiile-de-co2-de-la-autovehicule-date-si-cifre-infografic>.

[18]. ***, <https://auto.radacini.ro/masini-hibrid-si-emisiile-co2-5-lucruri-de-stiut/>.

[19]. ***, Urs Muntwyler, The Implementing Agreement IA "Hybrid- and Electric Vehicle" of the International Energy Agency (IEA) the international cooperation program with a new record of member countries, World Electric Vehicle Journal Vol. 5 - ISSN 2032-6653, WEVA, 2012.