

Environmental impact of road transport in Portugal and effects of hydrogen technologies penetration

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Abstract

Road traffic is one of the transportation sectors with faster growth due to the of vehicle fleets increase and a strong investment in road infrastructure and also one of the most important emitters of greenhouse gases (GHGs). With introduction, in this sector, of a new renewable fuel, like hydrogen, a reduction of the reported pollutant is foreseen. In this work, an analysis of the environmental benefits resulting from the introduction of hydrogen on road transport in Portugal is made. Impact is analyzed mainly looking at the pollutant emissions provided by road transport at the point of use. The software chosen to calculate the emissions associated to road transport is the COPERT program (version IV) since it provides a detailed methodology for each specific pollutant related to the vehicle fleet of a region or country, as well as the driving conditions and fuel consumption..

Keywords: Road transport, pollutants emissions, COPERT 4, Hydrogen Roadmap, hydrogen technologies.

1 Introduction

Road transportation is one of the most important emitters of greenhouse gases (GHGs) such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). It is also a significant emission source of pollutants, for instance (SO_x), (NO_x), (CO) and non-methane volatile organic compounds (NMVOC) indirectly responsible for the formation of ozone (O₃) in the lower troposphere. Substantial emissions of ammonia, particulate matter and heavy metals, result also from transportation activity while exhaust emissions result from the combustion.

A reduction of the reported pollutant is foreseen with the introduction of clean fuels, such as renewable hydrogen.

In this work, different scenarios for road transport (with and without hydrogen) are developed from 2005 to 2050 and the correspondent pollutant emissions are calculated.

It is considered that the hydrogen technology is driven to the market in 2020 and will be the dominant technology in 2050 for the most optimistic trend.

Passenger cars, light duty vehicles and public transport buses are the vehicles categories in which the hydrogen technology is foreseen. Two trends

are considered, which give moderate and high penetration rates for respective scenarios.

The software and methodology chosen to calculate the emissions associated to road transport is associated to the COPERT program.

2 Procedure

The software COPERT (COmputer Programme to calculate Emissions from Road Transport) is used, in its beta version 4, which is the fourth update of the initial version COPERT 85 (1989) [1]. The software estimates emissions of all regulated air pollutants (CO, NO_x, VOC, PM) produced by different vehicle categories (passenger cars, light duty vehicles, heavy duty vehicles, including buses and coaches, mopeds and motorcycles) as well as CO₂ emissions on the basis of fuel consumption.

Emissions are also calculated for an extended list of non regulated pollutants, including CH₄, N₂O, NH₃ and SO₂. COPERT calculates the pollution produced by one (or more) vehicles on yearly bases. The methodology is based on the calculations of the so called Emission Factors which quantifies how much of a pollutant is produced by a vehicle per Km.

In the first instance, COPERT 4 was used to the calculation of the pollution generated by the vehicle fleet in Portugal in the year 2005.

The input data is reported to different parameters, related to the country, fleet configuration, such as vehicles categories and vehicle classes as well as legislation standard according to built year. The activity data comprise values from the vehicle fleet (population), mileage, fuel injection and evaporation control. The speed values in different driving modes and different vehicles type are also consider.

The vehicle fleets (passenger cars, light duty vehicles and buses), in which penetration of hydrogen technology is foreseen, were projected since 2020 until 2050. The hydrogen penetration rates (moderate and high) were extracted from Hyways [2]. Two trends are then considered, which give penetration rates of 40.0 % and 74.5 % in 2050 for the moderate and high scenarios respectively (see table1).

Table 1. Penetration rates for hydrogen technology on road transport.

Share car fleet	2020	2030	2040	2050
High	3.3%	23.7%	54.4%	74.5%
Moderate	0.7%	7.6%	22.6%	40.0%

3 Results and Discussion

The urban drive mode is mainly accountable for all emissions, followed by rural and highway modes. Figure 1 shows CO₂ emissions according to driving mode.

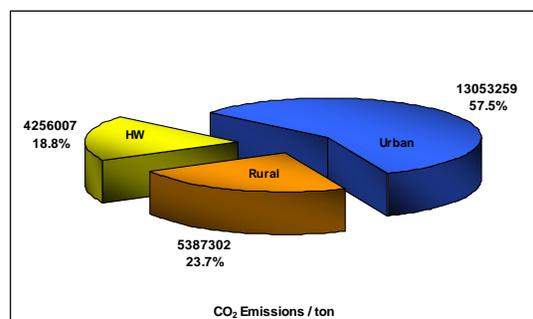


Fig. 1. CO₂ emissions (ton and %), according to driving mode for Portugal.

Passenger cars (PC) are the kind of vehicles which appear more polluting followed by light duty (LDV) and high duty vehicles (HDV).

Regarding CO₂ and CH₄ emissions the higher contributions come from LDV while for N₂O the higher contribution comes from HDV, see figure2.

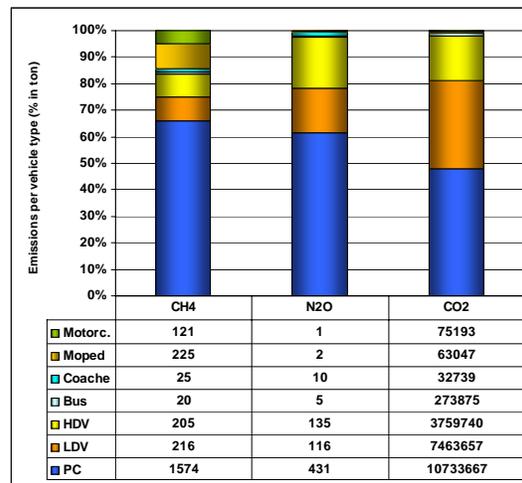


Fig. 2. CO₂, CH₄ and N₂O emissions, in ton, and their relationship with vehicles type.

For the year of 2020 the differences of data for gas emissions, in the scenario with hydrogen technology penetration and otherwise in absence of this technology, give small decrease since the penetration rate is a reduced percentage. From 2030 until 2050 the penetration of hydrogen in the road transport has a more significant increase (see table 1) and consequently a decrease in the gas emissions; in addition, in a scenario in the absence of hydrogen technology penetration, emissions are reported to increase. Figure 3 reveals an increase in the emissions from 2005 up to 2050 in the absence of penetration of hydrogen technology for CO₂.

The penetration of hydrogen technology is significant for the high penetration scenario (HP). Data for moderate penetrations of hydrogen (MP) are less relevant, although restraining the natural increase of the emissions.

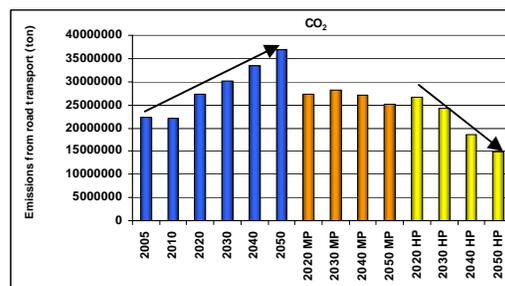


Fig. 3. Copert 4 values for CO₂ emissions, in ton, from 2005 to 2050, in presence and absence of hydrogen penetration rates (MP/HP).

References

- [1] COPERT: <http://vergina.eng.auth.gr/mech/lat/copert/copert.htm>
- [2] HyWays-Integrated Project to Develop the European Hydrogen Energy <http://www.hyways.de/>