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Eco-rating methodologies for private cars: driving cycle influence

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Abstract

Several environmental vehicle rating tools have been developed in order to promote the purchase and the use of greener cars. However those were developed/applied at a regional/country specific level. There is a need to develop a broader methodology that can be applied in a multi-country perspective for the assessment of the environmental rating of vehicles with alternative types of fuels as well as different types of drivetrain, such as electric, hybrid, plug-in hybrid and fuel cell hybrid. The environmental indicators usually relates to greenhouse gas emissions (GHG), air pollutants emissions (HC, CO, NO_x, PM, SO_x) and noise levels. US rating methodology developed by ACEEE is guided by Life Cycle Analysis (LCA), but disregards noise impacts (scores vehicles from zero to 100 (best)). EcoScore Belgian methodology adopts a LCA perspective, disregarding the materials of vehicle impact, but giving some importance to the noise impact (scores from zero to 100(best)). The German Verkehrsclub Deutschland's (VCD) current rating system does not purport to be an LCA, and it has been modified based on evolving views about the importance of various automobile impacts. VCD scores from 0 to 10 (best). It considers impacts in nature both from CO_2 (vehicle manufacturer information) and pollutants (European Standards), in human health from pollutants, also considers noise. Australian Green Vehicle Guide (GVG) rating methodology considers only usage stage, giving zero to 10(best) points to GHG and air pollutants, disregarding noise. The overall rating is based on the sum of the air pollution and greenhouse ratings (zero to five star (best)). For the vehicle in-use emissions usually a non-realistic, standard, driving cycle is used and again differs from country to country, despite aiming at representing urban and extra-urban driving.

This paper presents the application of the revised methodologies to existent alternative vehicle technologies, pure electric vehicle (Nissan Leaf), gasoline hybrid (Toyota Prius), plug-in hybrid (Toyota Prius), conventional gasoline (VW Beetle TSI), conventional diesel (VW Golf 2.0 Bluemotion), where the urban and extra-urban driving is considered in the same fashion at a multi-country level. Preliminary results of the methodologies rank highly Honda FCX Clarity and Nissan Leaf. Conventional vehicles occupy bottom places in the rankings. The influence of the driving cycles is discussed.

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*Keywords:*Environmental rating; alternative tecnologies; light-duty vehicles; driving schedule.

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1. Introduction

Environmental impact of the use of road vehicles is a matter of concern; governments are applying different policies to decrease fuel consumption and emissions. For governments this subject is of particular concern once it also implies economic impacts –both from nationals' health and fuel importation.

In fact in order to obtain a cleaner local and global environment there is the need to change the behavior of individuals regarding private transportation; the main question is where to start.

Several actions to reduce light-duty vehicles impact are being enforced worldwide, usually from governments (top to bottom approach), but some initiatives come from non-governmental agencies. Cities administrations' are applying different policies in order to obtain a cleaner environment, for local emissions reduction main strategy seems to be the applications of "low emissions zone", which means that vehicles prior to a certain year or legislation are not allowed to circle in a well-established area, usually town/historical centers. Also some experiments regarding the prohibition to circle in the city for random vehicles in certain week days or daily hours were conducted, for instance in Mexico city, a policy for vehicles not being able to enter the city in certain days according to the last number of their license plate was implemented. The efficacy of these measures is not always as expected, as may be seen in (Silva 2013; Davis 2008; Carslaw and Beevers 2002; Baptista et al. 2012). Country governments are also applying some incentives measures in order to reduce the amount of high emitter vehicles in the roads, by attributing financial retributions for vehicle disposal/purchase of greener vehicles (electric vehicles, hybrid vehicles and plug-in hybrid vehicles); taxation indexed to the CO_2 emissions and reduced taxes for cleaner vehicle technologies for instance. Since July 2005, United Kingdom launched the "Green Label" that is intended to let the consumer know about the environmental impact that a particular car will have by detailing the amount of CO_2 the car will produce per kilometre. These bands are consistent with the vehicle registration tax (VRT) and annual motor tax for new cars, calculated on the basis of carbon dioxide (CO_2) emissions from vehicles.

The awareness of inhabitants regarding vehicle usage impact is of high priority, thus at a broader level country governments applied vehicle labeling regulations in order to inform end user of the vehicle fuel consumption and CO_2 emissions (EPA 2011; EC 2000). In terms of pollutants, regulation for vehicles in market is mandatory for automotive manufactures' products to comply with emissions legislation, for instance in Europe (EU) the euro standards and for United States (US) Tier or California LEV emission standards.

At a non-governmental level some rating methodologies assess the vehicles' environmental impact by comparison with other vehicles in order to develop end-user awareness, for example, United States American Council for an Energy-Efficient Economy (ACEEE) Greenscore, Belgium Ecoscore, German VCD and Australian Green Vehicle Guide (Vaidyanathan and Langer 2011; Timmermans et al. 2006; ADIT 2004; VCD 2012). These methodologies are being applied in each country and comprise different parameters; some consider vehicle total life cycle, others partial life cycle, but all of them assess vehicle usage. Vehicle usage is a parameter that at the moment is considered dependent of the geographical area and usually is characterized by using directly or indirectly the regulation cycles of the locations for ranking calculation purposes. Driving cycles used are considered to replicate typical driving for each country, for instance New European Driving Cycle (NEDC), which is a stylized cycle used for vehicle emissions certification and fuel consumption measurements in Europe, is supposed to represent four times an ECE urban based cycle which represents urban driving conditions, characterized by low engine load, low speed and low exhaust gas temperature and a EUDC cycle which is representative of an extra urban driving cycle characterized by a most aggressive driving mode and higher speed. As another example, Federal Test Procedure (FTP-75), which is the US driving cycle used for vehicle emissions certification replicates an urban driving cycle. For fuel consumption the Corporate Average Fuel Economy (CAFE) is used and a combined urban (FTP) and extra-urban driving (EPA Highway Fuel Economy Cycle - HWFET) is used in a 55/45% weighting system. These are examples of cycles, used for certification purposes; however they are not much representative of real driving conditions. There are several studies that compare