Energy Policy 37 (2009) 3832–3842

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

CO_2 emissions from new cars and vehicle weight in Europe; How the EU regulation could have been avoided and how to reach it?

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ARTICLE INFO

Article history:
Received 2 June 2009
Accepted 15 July 2009
Available online 14 August 2009

Keywords:
Fuel economy
Backcasting
Policy analysis

ABSTRACT

A segment- and fuel-disaggregated analysis of the production data of the new European vehicle market during the last decade helps to understand the sharp increase in average weight, and to introduce an indicator linking CO_2 emissions to a vehicle's unit of weight. Using this indicator, simulations are made to calculate the average CO_2 emissions if the average weight had stayed constant from 1995 to 2005. If the weight had remained constant, the 2008 target of 1998s voluntary agreement (VA) would have been met, and the recently approved regulation would probably have been unnecessary. Then, CO_2 emissions are projected to 2015 using different vehicle characteristics and market penetration. Five scenarios have been introduced to study the different opportunities that could arise by 2015, including a backcasting scenario showing what is needed to reach the goal set by the recently approved EU climate package regulations. The analysis concludes that powertrain technologies alone are unlikely to bring the sufficient break in trends to reach set targets. Acting on average weight, through unitary vehicle weight or segment shifting, of new vehicles is key in reducing the average CO_2 emissions in the short and medium term.

1. Introduction

The European Commission and the ACEA (European Automobile Manufacturers' Association) agreed to sign in 1998 a VA aimed at reducing the CO_2 emissions of the average vehicle sold in Europe.[1] In 1995, vehicles sold in the EU-15 averaged a value of 186 gCO_2/km. The target set by the VA was 140 gCO_2/km in 2008 to reach 120 gCO_2/km in 2012. Following this agreement, the Japan Automobile Manufacturers Association (JAMA) and the Korea Automobile Manufacturers Association (KAMA) also agreed to reach the same CO_2 emission target of 140 gCO_2/km by 2009, for all vehicles sold in Europe.

Although the mid-term target of 165–170 gCO_2/km in 2003 was achieved, progress slowed down and it became clear that the 2008 target would not be met, not to mention the 2012 objective. As the VA was not being implemented as expected, the EU commission[2] raised, in the second half of 2006, the possibility of a legislation to cut CO_2 emissions if no change in the trend occurred. In February 2007, the commission announced plans to propose a legislative framework by mid-2008.[3] By 17 December 2008, the climate change package had been adopted, including the regulation aiming at reducing the CO_2 emissions from new cars. In the new legislation, 65% of new vehicles sold have to meet 130 gCO_2/km on average by 2012, 75% in 2013, 80% in 2014, 100% by 2015. This paper analyses the conditions required to reach this target by 2015. The paper is divided into two main parts; the first half analyses past trends of the European automotive market through the analysis of a detail database of the European automobile production, followed by a short term prospective approach to find out how the car industry will have to evolve to reach the recently approved legislation on CO_2 emissions for all new cars by 2015.

IEEP, CE, TNO (2007) were asked by the EU commission to analyse the options available for the legislative framework and perform an assessment for each of them. A sloped (utility based) "limit function" was recommended in order to take into account the different characteristics of the various Original Equipment Manufacturers (OEMs) in Europe. EU (2007a) opted for a utility function composed only of vehicle mass in defining a limit value curve for the permitted emissions of CO_2 for new vehicles.[4]

The first part of this paper analyses the evolution of the main parameters of the average European vehicle produced by ACEA, JAMA and KAMA manufacturers, who represent more than 95% of vehicle production and sales in Europe. Then, an indicator

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[1] http://ec.europa.eu/environment/air/transport/co2/co2_agreements.htm, last viewed 22/05/2009.

[2] EU Commission, COM(2006) 463 final.

[3] EU Commission, COM(2007) 19 final.

[4] The limit value curve is a continuous function defining the maximum CO_2 at any given vehicle mass.

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doi:10.1016/j.enpol.2009.07.036

showing CO_2 emissions per unit of vehicle mass is introduced for the different segments and brands. The impact of four different vehicle designs, involving different weight and technological evolutions, is then scrutinised according to the market penetration and the unitary emission gain. Finally, five scenarios have been developed in order to study the impact on CO_2 emissions of the introduction into the market of the three alternative vehicle types introduced in this paper. Depending on penetration rates and category shifts, the conditions needed to reach the target set by the regulation will be highlighted through the adoption of a backcasting scenario.

2. Data sources

Under the Monitoring Decision 1753/2000/EC, the EU does not provide sufficiently detailed data to allow the analysis to be developed in this article. The database, courtesy of Global Insight inc., contains the production level of every model manufactured in Europe from 1995 to 2005. Further years are available but have not been made accessible at the time the analysis was performed.

In Table 1, the consistency of the data is cross checked with the figure published by the ACEA. Their data covers all car production from all manufacturers for the 15 EU car producing countries. To check the validity of Global Insight's data, the same countries have been extracted from the database to be compared to ACEA data. As Table 1 shows, the database from Global Insight can be considered very consistent with ACEA's national production figures as a difference of less than 1% has been encountered in total production figure (the bigger gap in 2003 can be explained by the fact that the ACEA did not publish any production figure for Poland that year).

The VA only involves brands included in any of the three Manufacturers association ACEA, JAMA, KAMA; the brands that are not affiliated with any of the three associations are thus not taken into account for the analysis (nor are the niche manufacturers that are nevertheless concerned by the new EU regulation); they represent roughly 5% of European production over the 1995–2005 period. Even though the new target is only applicable to vehicle sales in the EU-27, the whole European production of the ACEA, JAMA and KAMA members (including Turkey and Russia) has been taken into account to study past trends, and to take into account the internal new vehicle flows within Europe.

This first part of the paper is based on production data; the difference between production and sales (on which the regulation is based) in Europe are the exports/imports. Fig. 1 highlights that since 1998 (year of the VA), the gap between average CO_2 emissions of the ACEA production in Europe and sales in EU-15 is growing. This means that ACEA's brands are exporting more and more high CO_2 emitting vehicles and the question is whether the VA encouraged exports of European made fuel eager vehicles outside the EU15 (zone considered for the ACEA Sales time series shown in Fig. 1). This question will not be addressed in this article as it focuses on Europe's future legislation.

Table 1
Contiguity between ACEA and Global Insight production data.

	Year		
	2003	2004	2005
Global Insight	15,846,551	16,019,978	15,753,740
ACEA	15,440,490	16,008,491	15,723,949
Difference (%)	2.5	0.1	0.2

3. Evolution of the main parameters between 1995 and 2005

This analysis focuses on the evolution of the main vehicles characteristics between 1995 and 2005. Weight and associated CO_2 emissions per unit of weight are of particular interest as the average CO_2 emissions target of the new EU regulation depends on the weight of the vehicle. To place the weight issue into a wider context, Fig. 2 shows the evolution of the main parameters related to the powertrain and the overall vehicle design that could lead to better fuel economy and reduced CO_2 emissions.

Vehicle production has been aggregated by:

- *Type of fuel*: gasoline and diesel engines have been split to highlight the importance of the dieselisation of the market.
- *Size*: the 18 segments and sub-segments presented in the original database have been grouped into three vehicle size categories as shown in Table 2.

The aggregated data for the categories and parameters detailed above are summed up in Table 3 for 1995, 2000 and 2005, using (1) to calculate weighted averages.

Let E_{ysf} denote the average CO_2 emission for year y, segment s and fuel f;

Let m_{ysf} denote the market share of segment s and fuel f in year y;

The average CO_2 emission for year y is then

$$E_y = \sum_{sf} m_{ysf} E_{ysf} \quad (1)$$

With a base 100 index fixed in 1995, the evolution of these parameters highlights the fact that dieselisation is the key parameter that has more than doubled over 10 years, and that power increases faster than weight, as shown on Fig. 2. For 2005, the value between brackets reflects the averaged value for vehicle sold, which is 8 gCO_2/km below the average produced vehicle as seen on Fig. 1.

Between 1995 and 2005, the European market underwent an important evolution, both in the type of vehicle produced and in the technology adopted. In Cuenot and Papon (2007), the analysis of the 1995/2000 and 2000/2005 periods made conclusions about the impact of the VA on CO_2 emissions, and whether it is due to the OEMs or market circumstances. The main conclusion of this study highlights the fact that between 1995 and 2000 (when the VA had not come into effect) the decrease in CO_2 emissions was due to technology. More surprisingly, between 2000 and 2005, the CO_2 emissions reduction is mainly due to dieselisation.

4. Weight historical trends in Europe

Fig. 3 shows the weight evolution from 1995 to 2005 of vehicles produced in Europe; by fuel and simplified segment as defined in Table 2. Data has been collected using various sources, such as EU (2007b), Global Insight[5], ADEME (2009).

Weight has increased substantially from 1995 within nearly all segments, with the average European production gaining 100 kg every 5 years. The only segment that saw its weight reduced is the MPV/SUV segment. This is due to the fact the smaller MPV/SUV (corresponding to MPV-C, SUV-B and SUV-C segments) were introduced in the early 2000's bringing down the average size and weight of this class of vehicle.

From 1995 to 2005, the assumption has been that fuel efficient technologies are not heavier than non fuel efficient technologies

[5] For more information on Global Insight data services, see: http://www.globalinsight.com/ProductsServices/ProductDetail721.htm, last viewed 22/05/2009.