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Options for Limiting CO_2 Emissions from Passenger Cars

Contents

1. CO_2 Emissions from Passenger Cars

Spurred by looming climate change, the European Union (EU) is supporting ambitious targets for reducing emissions of climate-active gases. On 8 March 2007, the EU member states agreed in principle to cut their output of CO_2 by one fifth between 1990 and 2020. If other high-emission countries undertake similar obligations, the EU would then raise its reduction target to 30% [1]. Currently, the transport sector accounts for 21% of total emissions in the EU-15. While all other sectors – energy, industry, household, business/trade/services – have reduced their emissions since 1990, output in the transport sector has risen by around 26% [2]. In Germany, passenger car CO_2 emissions make up 12% of the total output from all sources [3]. Moreover, specific emissions from passenger cars in Germany dropped only slightly between 1998 and 2006, from 188 to 172.5 g CO_2/km, and this downward trend has since stagnated.

In order to achieve the ambitious reduction targets set, it is absolutely essential to lower emissions from passenger cars.

2. Emissions Reduction Regulations to Date

Until now, the EU strategy for the transport sector was based primarily on the voluntary commitments made by the automotive industry[1]: The automobile manufacturers associations ACEA[2], JAMA[3] and KAMA[4] declared their commitment to the EU to limit average CO_2 emissions from their newly manufactured and registered passenger car fleet in EU 15 countries to 140 g CO_2/km by 2008 (for the ACEA) or 2009 (for JAMA and KAMA). Looking further, the Commission wants to lower average CO_2 emissions by 2012 to 120 g CO_2/km in newly registered car fleet (NRCs).

The German government, the European Commission and the ACEA have now concluded that the promised targets can no longer be attained by 2008. The conclusions of the Council published on 16 October 1999 in this case call on the Commission to present proposals for nonetheless achieving the Commission target for 2012.

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[1] The other two pillars of the regulation are the promotion of fiscal instruments and the dissemination of information to consumers.

[2] Manufacturers represented in the European Automobile Manufacturers Association (ACEA): BMW AG, DaimlerChrysler AG, Fiat S.p.A., Ford of Europe Inc., General Motors Europe AG, Dr. Ing. H.c.F. Porsche AG, PSA Peugeot Citroën, Renault SA, Volkswagen AG, AB Volvo.

[3] Japanese automobile manufacturers represented in the JAMA: Daihatsu, Fuji Heavy Industries (Subaru), Honda, Isuzu, Mazda, Nissan, Mitsubishi, Suzuki, Toyota.

[4] Korean automobile manufacturers represented in the KAMA: Daewoo Motor Co. Ltd., Hyundai Motor Company, Kia Motors Corporation.

In its communication of 7 February 2007, the Commission announced that it would stick to its target of 120 g CO_2/km by 2012, but that it no longer wished to realise this goal alone through technical improvements in engine and vehicle efficiency [4]. A reduction equivalent to 10 g CO_2/km is to be achieved through other measures such as the increased use of biofuels and improved tires. This means that a passenger car emissions reduction from 161 g CO_2/km in 2004 [5] to 130 g CO_2/km must be attained through improvements in vehicle technology.

European-level discussions have been underway since late 2006 on a new successor regulation for reducing CO_2 emission from passenger cars that would supersede the voluntary commitment strategy. This regulation would cover all new cars registered in Europe.

3. Possible Successor Regulation

3.1 Approach

The UBA examined various instruments for realising the Commission's target (including baseline and credit approaches, a number of different emissions trading schemes and manufacturer limits) and analysed their potential for bringing about efficiency increases, their feasibility and the time required for their implementation. After evaluating the various options, the UBA has concluded that a vehicle-specific CO_2-limit – comparable to the limits for classic pollutants – is the most effective instrument. We will discuss this limit proposal in detail below.

As the basis for its limit proposal, the UBA used the data provided by the German Federal Motor Transport Authority (KBA) on passenger cars initially registered in the first half of 2006 in Germany [6].

The UBA's proposal would make it possible to achieve a fleet average of 130 g CO_2/km by 2012 relying solely on technical modifications to vehicles.

3.2 Possible Reference Parameters for CO_2 Emissions

The simplest way of setting limits would be to place a direct limit on CO_2 emissions per kilometre that would be applied equally for all vehicles. The consequence would be to place large vehicles at a serious disadvantage as compared to small, low-powered vehicles. Moreover, this would ignore the specific efficiency of the particular vehicle, given that smaller vehicles with lower absolute CO_2 emissions are not per se especially efficient.

A suitable reference parameter must account for the various types of vehicle uses. We should therefore compare vehicles that offer the same utility.

To ensure the practicality and short-term implement ability of the proposal, the required data must be either available now or easily acquirable. The parameter should depict the

utility of the vehicles and not lure the manufacturer into making technical modifications to the vehicle that achieve compliance with the limits but leave fuel consumption unchanged. In other words, it must serve to avoid "paradox" effects. Parameters with no direct relationship to fuel consumption are therefore particularly well suited.

Possible parameters include displacement, rated output, curb weight, vehicle shadow area, vehicle volume and interior volume. These are discussed below.

Displacement

Using this parameter would allow higher CO_2 emissions in vehicles with greater displacement. This would thus entice the automotive industry to sell cars with greater displacement and unchanged fuel consumption instead of working to improve CO_2 efficiency. Reducing displacement ("downsizing"), on the other hand, offers significant potential for lowering fuel consumption.
The use of displacement as the reference parameter would likely bring about contra-productive results. If used as the reference parameter, it would not serve the intended purpose.

Rated Output

This parameter is of basic interest given the direct relationship between the rated output and fuel consumption – and thus to the CO_2 emissions – of the vehicle. But in real-life vehicle operation, rated output plays only a minor role, such as for rapid acceleration. Despite its low practical value, it is often a significant factor in selecting a car for purchase.
The problem is therefore similar to what we saw with displacement, namely that manufacturers might tend to focus on increasing the power output of their cars. The current problem of too many overpowered engines in the vehicle fleet would thus be exacerbated. This is therefore not a suitable reference parameter.

Curb Weight

A direct relationship also exists between vehicle weight and fuel consumption (fig. 3). Reducing a car's weight by 100 kg can be expected to improve fuel economy by 2.0 to 2.6% [7].
For comparison purposes, however, the curb weight is not wholly suited, since a limit based on weight provides no incentive for manufacturers to reduce the weight of their vehicles. A contra-productive development has already been seen with off-road vehicles, which were purposely given extra weight so that they could be categorised as light commercial vehicles and thus subject to lower tax rates. Curb weight therefore is also not suitable as a reference parameter.

Vehicle Shadow Area

No direct relationship exists between the vehicle shadow area and fuel consumption. Setting a limit that is correlated to the vehicle shadow area (length x width) is therefore a solution that offers manufacturers no direct possibility for altering their designs in order to circumvent the regulation. Although manufacturers could, for example, increase a vehicle model's shadow area within certain limits, styling considerations would preclude such measures. Except in the case of sports cars, the shadow area is also an indicator of the use of the vehicle (transport capacity for persons and goods). And it is a measure of how much space a vehicle takes up in traffic. The UBA therefore considers the vehicle shadow area to be a suitable factor for use in setting limits.

Vehicle Volume

The vehicle volume (shadow area multiplied by vehicle height) appears to represent a better criterion. But simply multiplying the given length by height by width specifications does not provide a true picture, since this would give us only the cuboid volume. High-roof, large-volume vehicles (such as vans), which often have poor fuel economy, would be favoured by this parameter, since they would be allowed higher emissions values than would otherwise be the case if the shadow area, for example, was used as the basis for setting the limits.

For these reasons, vehicle volume is less suited as a parameter for setting CO_2 limits.

Interior Volume

The interior volume (seating space plus luggage or load compartment space) provides a good indicator of the utility value of a vehicle. This factor is in principle well suited to serve as the reference parameter. The problem is that there is in Europe no single recognised method for determining the interior volume. Moreover, the national vehicle licensing agencies do not have the information that would in theory be required to calculate the interior volume. Manufacturers only provide data on luggage compartment volume. The interior volume can thus for practical reasons not be used as the reference parameter.

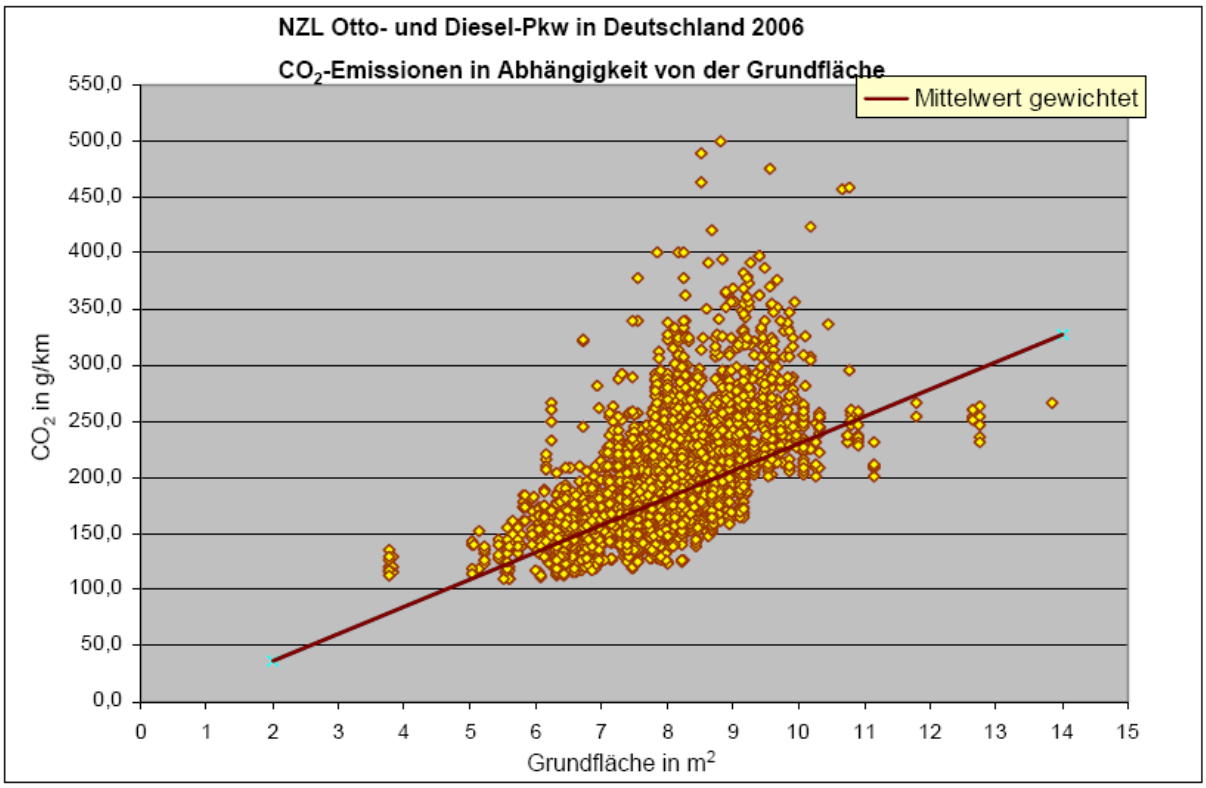
Result

The UBA believes that the vehicle shadow area, defined as the product of length times width, is the most suited and most promising reference parameter for CO_2 emissions under current conditions and in comparison with the other parameters described above. The data are available for all passenger cars. The shadow area is a measure of the

utility offered by a vehicle and can be modified only slightly within existing model series. This parameter will therefore be used for the further determination of limit values.

Fig. 1 plots CO_2 emissions against shadow area for newly registered gasoline and diesel cars in the first six months of 2006 in Germany. Each dot represents one version of a vehicle model on the German market. Most vehicle models are available with only one particular shadow area. The various versions of the same model that are equipped with various sized engines thus form a vertical column of dots in the charts, as seen in Fig. 3 with the VW models. This system highlights the effect of various engine sizes, vehicle weights, displacement values and other CO_2-relevant differences. Although the dots in the charts do not depict the different sales figures for the various models, the average value curve is weighted according to the number of vehicles sold in the first half of 2006. The average CO_2 emission is given as 172.9 g CO_2/km.

Fig. 1: New Gasoline and Diesel Cars Registered in Germany in 2006: CO_2 Emissions and Vehicle Shadow Area



3.3 Deriving the Limit Proposal

Based on the analysed data, the UBA has developed a limit proposal with two variants. The overriding objective was to comply with the targets set by the European Commission:

- Average emissions output among all newly registered passenger cars in 2012 shall be no higher than 130 g CO_2/km.

Other framework conditions:

- The implementation of practicable short and mid-term technical options for boosting efficiency that can still be realised in the majority of passenger cars.
- The effects of other instruments that also serve to improve efficiency should be taken into account, including better labelling, a CO_2-based motor vehicle tax and the trend for fuel price increases.
- Demands for reductions must apply to all segments (size classes).
- Simplicity and plausibility of the limit proposal.

Using the analysis of the emissions situation in 2006 (fig. 1), the average value curve of the limit was set such that the 2012 target average of 130 g CO_2/km would be attained. Here we assume that consumer purchasing behaviour will remain the same in each

segment. Using this "average value curve for newly registered cars in 2012" we can read the CO_2 emissions limit relative to shadow area for each vehicle model. The result is an improvement in vehicle efficiency of 20% on the average.

For the limit regulation to take effect in 2012, it must be passed prior to 2010. The UBA predicts that such a regulation will spur manufacturers to adapt their fleets early on, i.e. there will be more and more vehicles with better fuel economy (and hence lower CO_2 emissions and higher efficiency) available on the market well before the new regulations go into effect. The trend has already started as evidenced by the increased consumer demand for low-consumption cars. And this development has been reinforced by the recent announcements of several manufacturers to add a significant number of low-emissions cars to their product portfolios. The UBA considers a 20% increase in efficiency between 2006 and 2012 to be achievable.

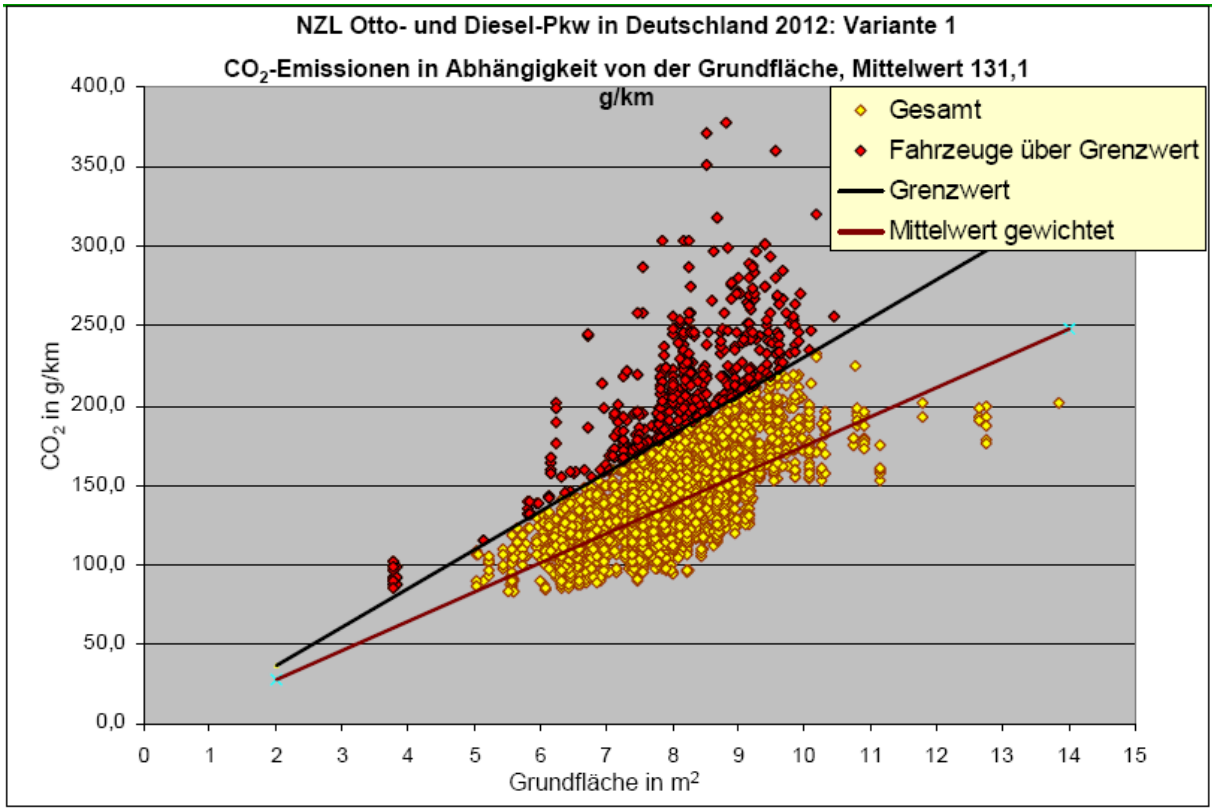
Manufacturers will shape their vehicle offerings such as to comply with the limit, minus a certain margin of safety, resulting in an increased share of vehicle models with emissions below the limit.

In consideration of the above framework conditions, the UBA has developed various limit variants. In carrying out this work, we varied the following parameters:

- Extent of energy efficiency improvement in new vehicles between 2006 and year of introduction,
- Position and slope of limit curve in relation to emissions targets for 2012.

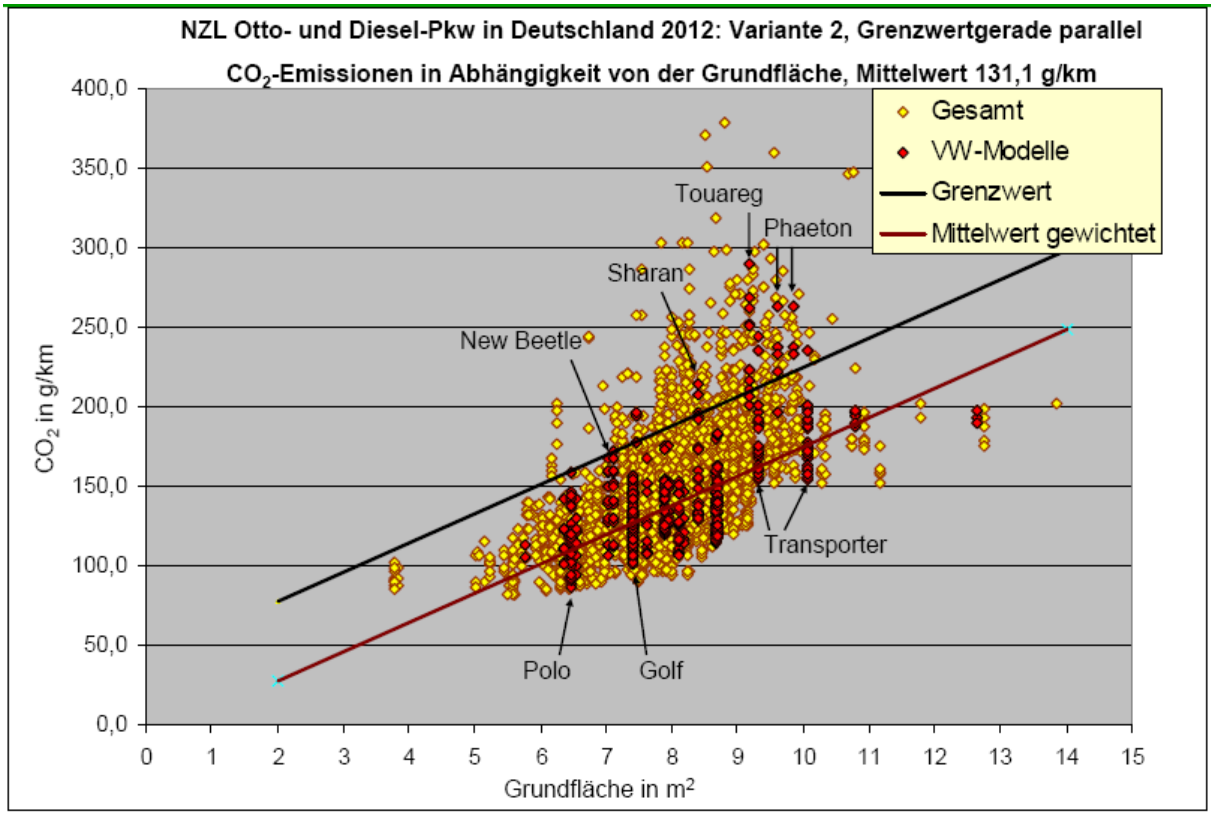
Variant 1: Variant 1 includes a CO_2 limit curve for 2012 corresponding to the weighted average value curve for CO_2 emissions from newly registered cars in 2006 (see figs. 1 and 2). Vehicles whose emissions in 2012 are above this curve will then no longer be eligible for registration.

Fig. 2: New Gasoline and Diesel Cars Registered in Germany in 2012: Variant 1, CO_2 Emissions and Vehicle Shadow Area



Variant 2: In Variant 2, the CO_2 limit curve for 2012, corresponding to the weighted average value curve for CO_2 emissions from newly registered cars in 2006, is set parallel to the weighted average value curve for 2012 (fig. 3). This is done to reflect the fact that manufacturers have a greater variety of technical options for improving efficiency in larger cars than in smaller ones [8]. As a portion of the total price, the cost to implement efficiency measures in larger vehicles is actually less. In addition, studies have shown that the annual distance driven in larger vehicles is significantly higher then in smaller vehicles [9].

Fig. 3: New Gasoline and Diesel Cars Registered in Germany in 2012: Variant 2, Limit Curve Parallel to Weighted Average Value Curve for 2012. CO_2 Emissions and Vehicle Shadow Area. Addition information for example: The situation of VW models.



3.4 Effects of the Limit Proposal

Variant 1: Assuming that a 25% efficiency increase will be technically possible in new vehicles by 2012, there will still be around 63,000 vehicles (approx. 3.8% of annual registrations) that exceed the proposed limit[5]. If registration is denied to these vehicles it would be possible to achieve a fleet average of approximately 129 g CO_2/km; otherwise the emissions value would be 131 g CO_2/km.

The effects on the individual manufacturers vary widely. For some, such as Citroën and Opel, nearly all vehicles would be eligible for registration, but this would be the case for only 93% of DaimlerChrysler and only 8% of Porsche cars.

On the whole, only a small number of models would be made completely ineligible for registration. For the most part, only high-powered versions of individual model series will be affected. Initial emissions reductions are relatively easy to achieve for

[5] According to data for the first half of 2006. The total for all of 2006 would thus be around twice as much.

manufacturers, for example by moving away from today's overpowered engines and installing fewer high-powered engines. Those models built by luxury carmakers such as Ferrari, Aston Martin or Lamborghini will still not be able to comply with the limit.

Variant 2: With this variant, only 2.6% of vehicles registered in a year will exceed the limit, even though the CO_2 fleet average for 2012 will be the same as under Variant 1. This is due to the fact that a larger percentage of small-shadow area vehicles with high fuel economy comply with the limit, while a smaller number of large-shadow area vehicles with low fuel economy exceed the limit.

For most manufacturers, the share of passenger cars with emissions exceeding the limit is slightly smaller than in Variant 1. For example, the consequences for Porsche ("limit exceeded") and the German automakers VW, Opel, DaimlerChrysler, Audi and BMW ("nearly all vehicles below limit") are similar under both variants. Presuming a 25% increase in efficiency by 2012, nearly all French cars will comply with the limit, compared with a non-compliance rate of 2.4% for Japanese cars and 3.0% for German cars.

Larger vehicles not only have higher specific CO_2 emissions per kilometre driven, they are also driven for greater distances [5]. They therefore emit a significantly greater amount of CO_2, both on an annual basis and across the total life of the vehicle. Existing regulations that serve to reduce the amount of specific CO_2 emissions, do not take sufficient account of the differences in distances driven by various vehicles. The UBA therefore favours Variant 2 as presented above, since it at least indirectly incorporates the factor of distance driven.

3.5 Transitional Regulation

Manufacturers possess a wide variety of options for improving vehicle efficiency over the short and medium term. Some measures, however, would require fundamental modifications to existing models, or even complete redesigns, and can therefore not be realised by 2012. In this regard, it is important to consider the product development cycle in the automotive sector, typically around five years [6].

The implementation of a "strict" limit from 2012 on would push a number of vehicle models out of the market. Especially those manufacturers who produce high-emission luxury brands would hardly have the opportunity to adapt their vehicles to comply with the new limits regulation.

After defining the limits curve, it therefore makes sense to apply a transitional regulation for a period of approximately five years, starting in 2012, that would include an additional fiscal component for vehicles that exceed the limit. This might, for example, include a levy that manufacturers must pay for vehicles that exceed the CO_2 emissions

limit. A manufacturers levy like this is already in place in the USA, known as the “Gas Guzzler Tax”.

4. Summary and Conclusion

The UBA has drafted a proposal for limiting CO_2 emissions for new gasoline and diesel passenger cars registered in Europe from 2012. The efficiency of vehicles is assessed with reference to the vehicle shadow area of passenger cars. The average CO_2 emissions figure for all new diesel and gasoline cars registered in Germany in 2006 was plotted against the shadow area as an average value curve, weighted for sales figures, and used as the basis for the proposal.

The limit proposal was based on the data provided by the German Federal Motor Transport Authority (KBA) on CO_2 emissions for newly registered vehicles in Germany in the first half of 2006. This data allowed us to analyse energy efficiency in relation to various reference parameters (e.g. curb weight, vehicle area). Using this data, we studied two limit variants, analysing how effective they would be in meeting the European target of 130 g CO_2/km in 2012.

In Variant 1, the average value curve, weighted for number of registrations in 2006, serves as the limit curve for new registrations in 2012.

Variant 2 reflects the argument that full-size cars are driven for greater distances than small cars and that the relative cost for efficiency improvements as a share of the total price is actually less than for small cars. Under this variant, the 2012 limit curve therefore runs parallel to the weighted average value curve for expected new registrations in 2012.

The result is that in 2012 approximately 3.8% of newly registered passenger cars will exceed the limit under Variant 1, while some 2.6% will do so under Variant 2. The majority of vehicles affected are high-emission cars in the full-size and luxury vehicle segment.

For the implementation of CO_2 limits legislation for passenger cars, the UBA favours Variant 2 because it accounts not only for specific CO_2 emissions, as in Variant 1, but also for the statistical variance in the distances driven in different sized cars, both parameters being decisive for total absolute CO_2 emissions.

In the years before this regulation goes into effect in 2012, manufacturers can make simple adaptations to existing models in order to incorporate fuel-saving technologies.

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