POLAND AT A CROSSROADS

THE IMPACT OF CO_2 AND FUEL ECONOMY REGULATION ON POLAND

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Poland at a crossroads
The impact of CO2 and fuel economy regulation on Poland

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1. Introduction

In July 2012 the European Commission published its proposal on fuel efficiency and CO_2 standards for new cars in the year 2020 (Review of Regulation 443/2009). The Commission proposes to reduce fuel consumption of new cars by almost 30% by 2020 to 3,8 l/100km[i] (or 95g CO_2/km). This proposal is currently being discussed by the Council and the European Parliament and is of singular importance to Poland.

Poland is a country with a rapidly growing car fleet and a equally growing thirst for oil. At the same time Polish cars, which are still by and large second hand cars, are a lot less efficient than the EU average. Because of lower incomes, Poles spend a relatively big part of their disposable income on fuel bills.

1.1 Car CO_2 and Fuel Economy

The EU's Cars and CO_2 Regulation of 2009 sets a standard for fuel efficiency and carbon dioxide (CO_2) emissions from cars for 2015, and a more stringent standard is currently under consideration for the year 2020. Although the standards set are expressed in grams of CO_2 per kilometre they effectively regulate average fuel efficiency of new cars as well. Indeed, the correlation between carbon dioxide emissions and fuel consumption is such that for every 10% reduction in fuel consumption, CO_2 emissions fall accordingly.
The existing regulation has already resulted in significant improvements in fuel economy of new cars sold in the EU and this is leading to measurable reductions in total fuel demand in some EU 15 countries.

Previous analysis has calculated the fuel cost savings which typical motorists will enjoy in each member state of the EU 15 under a range of assumptions as to the stringency of future standards, and found that these were very substantial. New car buyers enjoy similar benefits all over Europe. However, in many of the new Member States most of the cars sold are second hand ones, so this raises the question of how the new Regulation will impact upon fuel consumption in these countries.

This report investigates the impact of the CO_2 and fuel efficiency Regulation on second hand car buyers and extends the methodology used previously to estimate the savings that might result for motorists and governments in key EU Member States in Central and Eastern Europe (CEE).

1.2 Future Standards for Car CO_2 Emissions

To do this, a set of four scenarios of possible future CO_2 reduction targets were established for the whole of the EU. These reflected the current position, future expectations, and the technical potential for further emissions reductions. In order of increasing level of ambition, the five scenarios are as follows:

1. Do Nothing: The Cars and CO_2 Regulation passed into law in 2009 set a tailpipe standard for cars of 130g/km in 2015: the baseline case is for no further emissions reductions beyond that date – i.e. a base case or 'do nothing' scenario.

2. Commission Proposal Only: The Cars and CO_2 Regulation also sets a target for 2020 of 95g/km. This is now under review, but the Commission has proposed that this target be upheld. In this scenario, it is assumed that the 95g target is met but that nothing is achieved on fuel economy beyond this: i.e. no further progress after 2020.

2a. Super credit Scenario: As Scenario 2, but with extensive flexibilities and allowances included (most obviously for super credits) which are predicted to weaken the overall 2020 target to 105g/km.

3. Continuing Progress: As Scenario 2, but with further reductions to a 70g/km limit by 2025.

4. Ambitious Reductions: This scenario has a more ambitious 80g/km target for 2020 and 60g/km by 2025.

For each scenario, base case results were calculated for each Member State as set out in Annex 1 to this note. The base case reflects cost savings for an 'average motorist' – i.e. the main driver of a typical second hand car driving the average mileage for the country in question.

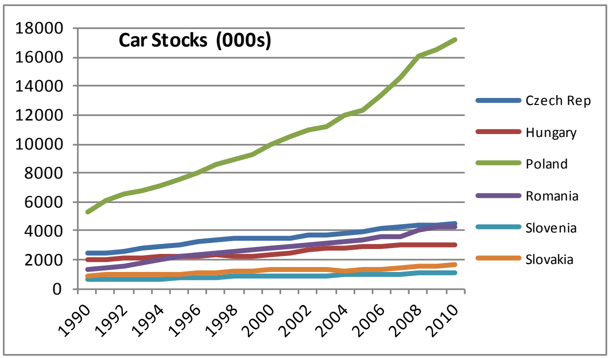
To develop an accurate picture, the next section of this report outlines some of the key features of the developing car stock in selected countries of Central and Eastern Europe, with a particular focus on growing car stocks and on the fuel economy and related carbon dioxide emissions of the cars in use.
The following section estimates the impact of the scenarios set out above on fleet average emissions and fuel economy in future years, while the last part explores the likely impact of future car fuel economy standards on fuel costs for motorists in these countries and on total national energy needs. The country selected include the main car markets within the EU 10, and are intended to be broadly representative of conditions across the whole region. Results presented in this report focus on the analysis for Poland.

2. Trends in Car Owneship and Use in CEE

This section highlights key features of the growth of car ownership and use in CEE countries, with particular emphasis on the way in which these trends will impact upon the take-up of more fuel-efficient cars in future years. Statistical data are based primarily on the publications of Eurostat (2012) and UNECE (2011).

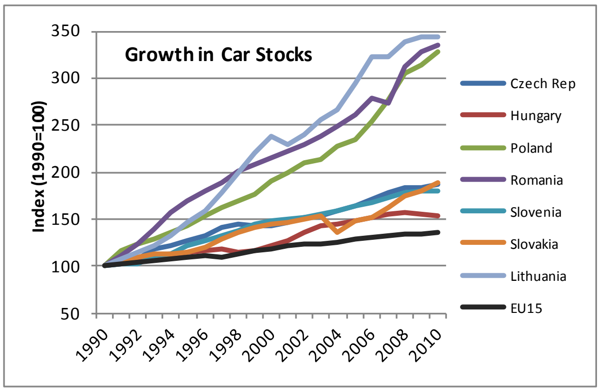
2.1 Background: The Rise in Car Ownership

In 1989, when the fall of the Berlin Wall marked the beginning of the breakup of the former Soviet Union, car ownership levels in the countries of central and eastern Europe were very low by the standards of the countries of the EU 15. Also, owing to the limited supply of vehicles available to purchase, the average age of the existing private car stock was already high. On the other hand, aside from a small percentage of larger limousines, most of the cars available were small and simple in design (many having two-stroke engines) and as a result offered good fuel economy by modern standards.

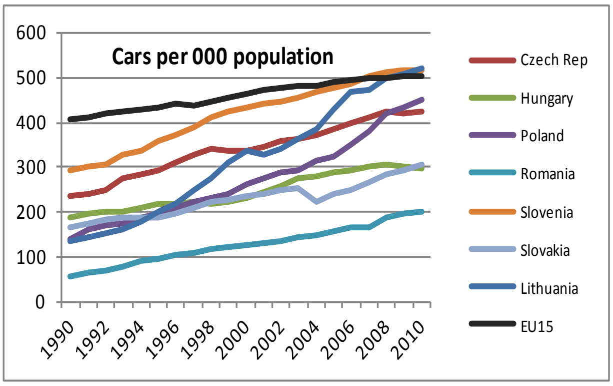


From that date, rising real incomes and the ready availability of car models from western Europe (both newly purchased and second-hand imports) combined with the continuing availability of regionally-produced cars led to a steady growth in total car ownership, as illustrated in the figure to the left. This effect is most pronounced in Poland, being the largest and most populous of the new member states.

However, Poland also experienced one of the most rapid increases in car ownership over the period, having (along with Lithuania and Romania) more than tripled the size of its car stock over the past two decades. The other EU 10 states shown appear to have experienced a similar upward trend, but it has been rather less rapid and from a lower base. In Hungary, for example, the total car stock appears to have grown by not much more than half over the same period. It should be stressed that the rate of increase in car ownership in the EU 10 is much more rapid than that which had been experienced over a longer period in the EU 15, and was in many respects unprecedented. As the graph illustrates, the EU 15 car stock has grown only slowly over the past two decades and now shows signs of stabilising.



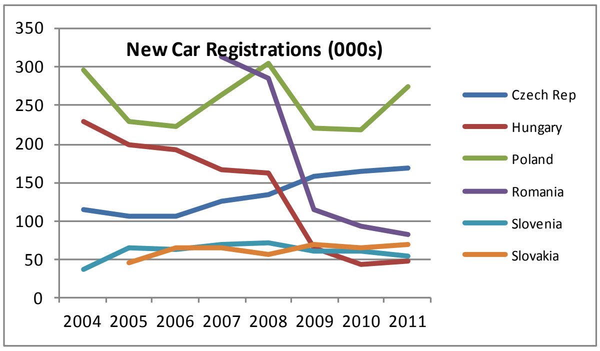
As noted, this rise is accounted for in large measure by the low levels of car ownership at the start of the period relative to those found in Western Europe, coupled with increasing personal income among some at least of the population. Even in 1990, it is apparent however that car ownership levels varied very significantly from country to country, ranging from only about 60 cars per thousand population in Romania, up to around 300 in Slovenia. In all cases, a fairly steady upward trend in the level of motorisation can be seen in the graph to the left, but as shown above, the rate of increase has been greatest in the cases of Poland, Lithuania and Romania. Slovenia and Lithuania have already exceeded the average for the EU 15, and Poland and the Czech Republic are not far behind. We may expect to see a continuation of the recent levelling off of car ownership levels in these countries, but experience in Western Europe strongly suggests that growth in car stocks may continue in the other states of the EU 10 for some time to come.



It is not however possible to predict the scale or duration of this trend with any great precision, as experience from western Europe suggests that the level of saturation car ownership can vary substantially from country to country, depending on economic, geographic and other factors. For example, the motorisation rate already exceeds 600 in Italy, but is barely above 400 in Portugal or Ireland. The latter are among the least affluent among the EU 15 countries, so further growth may be expected if their economies continue to grow — but probably not to the levels seen in Italy, or at least not in the foreseeable future. There are indications that saturation in car ownership levels may have been reached in some countries in Europe, whereby virtually everyone who can or wishes to drive a car has access to one and the rate of growth is slowing as a result; whereas in others this is probably not yet the case. It is also difficult to distinguish underlying trends in recent years from the impact of the prolonged economic recession; but it seems that for most countries, ownership saturation lies somewhere around the 500 to 550 cars per thousand mark. In Poland, several of the more prosperous provinces have already exceeded 500, and are well on their way to 550, so the latter seems like the more sensible choice as a central assumption. A higher possible value is considered in the sensitivity analysis in Annex 2.

Thus there is good evidence to suggest that Slovenia may be nearing car ownership saturation – and indeed, growth in ownership appears to have tailed off in recent years. For others, there is still some way, or possibly even quite a long way, still to go before this point is reached. It is important to note that whilst in saturated markets the total fleet is no longer growing, big changes within that fleet may still occur. Indeed, as more cars come onto the market, it becomes increasingly likely that the oldest cars in the fleet will be replaced with something newer, cleaner and more fuel-efficient, and thereby help to improve the average efficiency of the car fleet overall. This is already the established pattern in the EU 15.

2.2 New Car Sales in CEE Countries



For recent years, statutory reporting under the Passenger Car CO_2 Reporting Mechanism gives a reliable and comparable time series of new car sales in all EU member states. However, as the graph below illustrates, the trends that can be distinguished in the countries under discussion vary enormously according to national economic, social and policy conditions. For example, new car sales have clearly plummeted in Romania and Hungary over the last few years, presumably in response to deteriorating economic circumstances, whereas sales have remained steady in Slovakia and Slovenia, and continued to rise in the Czech Republic.

Furthermore, the relationship between new car sales and either the size or growth in national car stocks varies considerably. That is, new car sales are more than sufficient to account for the rise in car ownership in Hungary and Slovenia, and are broadly on a par with stock increase in the Czech Republic, Romania and Slovakia. In Poland, however, new car registrations are far too few to account fully for the growth in car stock, averaging only about 30% of the net increase in total stock. Given that a percentage of older cars are inevitably scrapped each year, this indicates that second-hand car sales play a significant role in the growth of car stocks in Poland in particular, and to some extent elsewhere as well.

2.3 The Significance of Second-hand Car Sales into Central and Eastern Europe

In 2011, a consortium of consultancies (led by Öko-Institut in Freiburg) produced a detailed data analysis of international movements of second-hand cars across the EU for the European Commission. On the basis of the best available data, they concluded in outline that Germany was by far the biggest exporter of second-hand cars, mainly into the countries of Central and Eastern Europe, and that the Netherlands and Belgium were also significant contributors. In terms of recipients, they found that Poland was by far and away the largest purchaser of second-hand cars from western Europe, although other EU 10 countries including the Czech Republic, Romania and Slovakia were also significant purchasers relative to the size of their total vehicle stock.

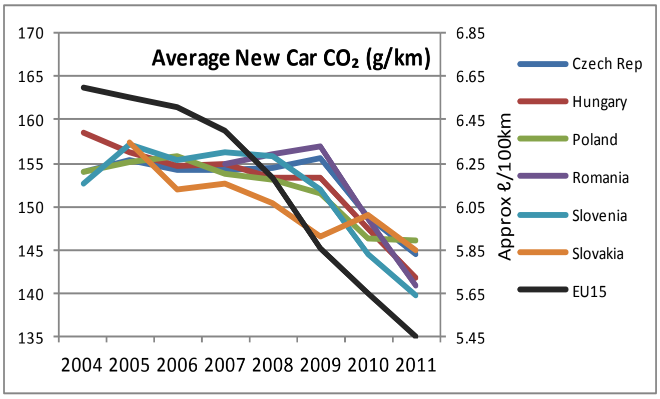
Aggregating data for both cars and vans for the single year 2008, they produced summary estimates as follows:

	Estimated Imports	New Registrations	Ratio Used Imports:New
Czech Republic	206456	202823	102%
Hungary	28818	174837	16%
Poland	1144033	375936	304%
Romania	223307	307409	73%
Slovenia	20249	78857	26%
Slovakia	103948	96940	107%

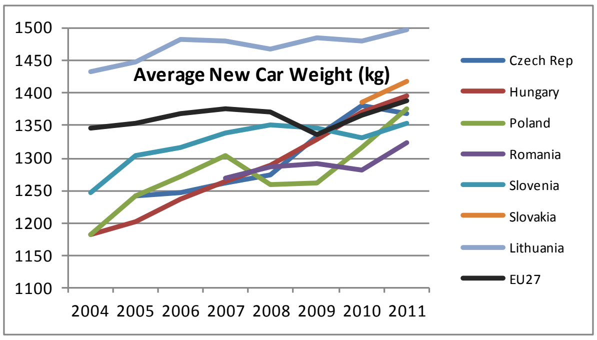
Note that, for Slovenia in particular, the picture is further complicated by the fact that more second-hand vehicles are re-exported each year than are imported. This reflects in part Slovenia's close and long-standing links with neighbouring Austria. In Hungary, punitively high registration tax rates discourage the importation of old vehicles and those with high engine capacities, and this helps to explain the relatively low incidence of second-hand imports there.

Aside from these two, it can be seen that second-hand imports are an important feature of car markets in most CEE countries, which needs to be reflected in any attempt to estimate how CO_2 emissions and fuel economy will change in future years. Fleet fuel economy is likely to continue to be heavily influenced by continuing second-hand imports as well as changes in the fuel efficiency of new cars entering the EU-wide car fleet.

2.4 Average CO_2 Emissions from New Cars in CEE



With reference to the CO_2 emissions and hence fuel efficiency of new cars purchased in Central and Eastern European countries, a more consistent pattern emerges. That is, average emissions have typically fallen from around 155g/km to a little over 140g/km (equivalent to fuel economy of approximately 6.3 to 5.7 litres/100km) over the eight years for which data are available. This is a significant improvement in all countries, although markedly less than the improvement in the EU15, which began the period with average emissions well above 160g/km, but which have now fallen below 135g/km or 5.4 litres/100km.

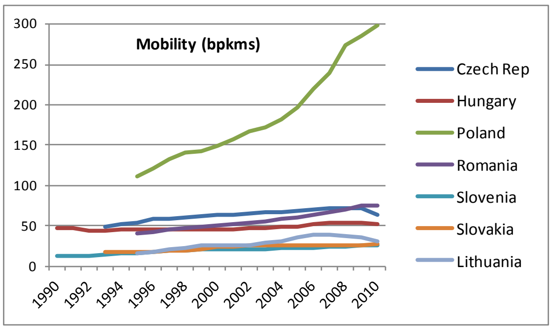


This appears to be primarily because the average weight of the cars purchased in the EU 10 has grown fairly steadily in recent years. There has been a slight upward trend across the whole of the EU, but it is much more marked in the countries under consideration here, typically amounting to at least 100kg per car, or even 200kg in some cases. This is because historically, car buyers in CEE countries tended towards lighter cars, but now are gravitating towards the EU average. This in turn implies that, over time, new car purchasers in the EU 10 are tending towards models that are larger or more luxurious or both. This trend in itself has partly counteracted the improvement in fuel economy that has been observed across the EU as a whole.

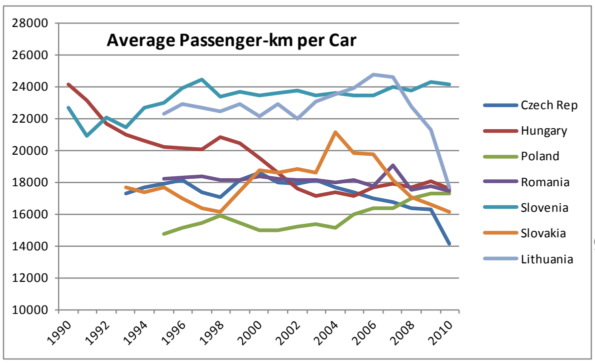
We do not have information of anything like this level of detail on the average CO_2 emissions of the cars that are imported second-hand into CEE countries. In the absence of such information, we can only assume that these are broadly in line with average emissions from all the new cars sold in the EU 15 in the year in which a given vehicle was manufactured.

2.5 Trends in Vehicle Use

In terms of total car-based mobility, official statistics from the past two decades show a steady upward trend in total passenger kilometres travelled by car over the whole period, reflecting both an upward trend in distance travelled per passenger, but also a steady shift away from public transport towards car use. The upward trend is by far and away the most rapid and most marked in Poland. In some cases, the trend has slowed or even reversed in recent years, but experience elsewhere suggests that this is associated with the recent economic downturn, and that growth may well resume once market conditions improve.

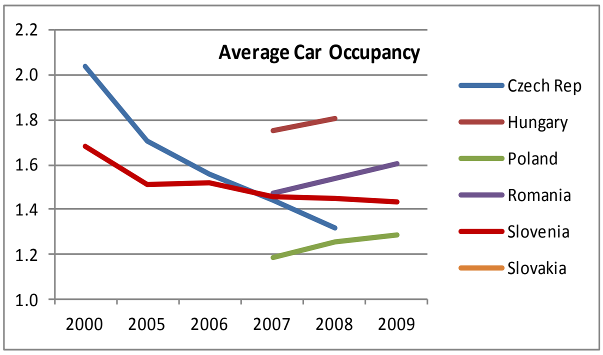


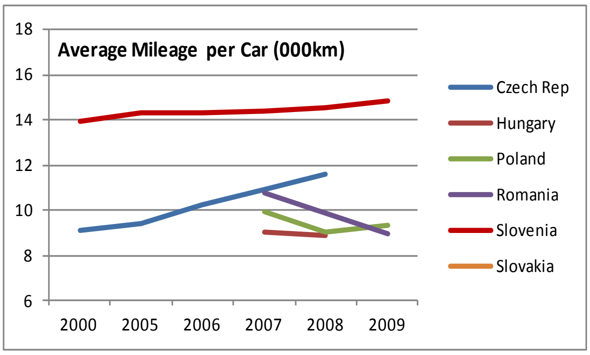
However, when the trend in passenger kilometres is normalised against the growing number of cars available in each



country, this upward trend is largely cancelled out, illustrating that the upward trend is largely a function of the increasing numbers of cars available, which are allowing people either to travel further through the use of a car, or to shift away from public transport use, or both.

From the point of view of calculating future fuel consumption, the distance travelled per *vehicle* is far more important than the distance travelled per passenger. In particular, a level trend in passenger kilometres per vehicle may mask a decline in average vehicle occupancy in association with an increase in distance driven. Historically, such trends were not uncommon in the EU 15. Unfortunately, data on levels of vehicle traffic are relatively scarce for CEE countries and may not be entirely reliable owing to difficulties of measurement.





Of the two countries for which consistent time series data are available, only the Czech Republic shows a marked reduction in average car occupancy — from more than two people per car to barely half that in less than 10 years — associated with a fairly substantial increase in the average distance driven per vehicle over the same period. Slovenia shows similar traits though to a much less marked extent — not least perhaps because the average distance driven per car is already far closer to typical western European values than those for other CEE countries. For the other countries studied, for which far more limited time series data are available, no clear trends are visible at all.

In summary, therefore, it is difficult to conclude that there is a clear upward trend in the distances driven in a typical car in most of the CEE countries examined. For all countries apart from Slovenia, these distances remain far below those commonly found in EU 15, but there are not as yet clear signs that they will converge with the typical distances driven in EU 15. However, this does not preclude the possibility that distances driven will increase in future, for example in reflection of improved driving conditions (expansion and improvement of road infrastructure) or standards of living. As discussed below, uncertainties around this issue could have a major impact on future fuel demand in CEE countries.

2.6 Conclusions from Section 2

- Available data are good enough to generate a fairly clear picture of the development of car stocks, allowing a simplified model of stock turnover in CEE countries to be developed

- Situations in different countries vary significantly, so each chosen country needs to be modelled separately in order to reflect local conditions
- Second-hand car imports are clearly important and cannot be ignored, so the model used must reflect this fully
- In most countries there is no clear evidence of a trend in increasing distance driven per car; but evidence from EU 15 suggests that such a trend might develop in future in countries where it is not yet evident

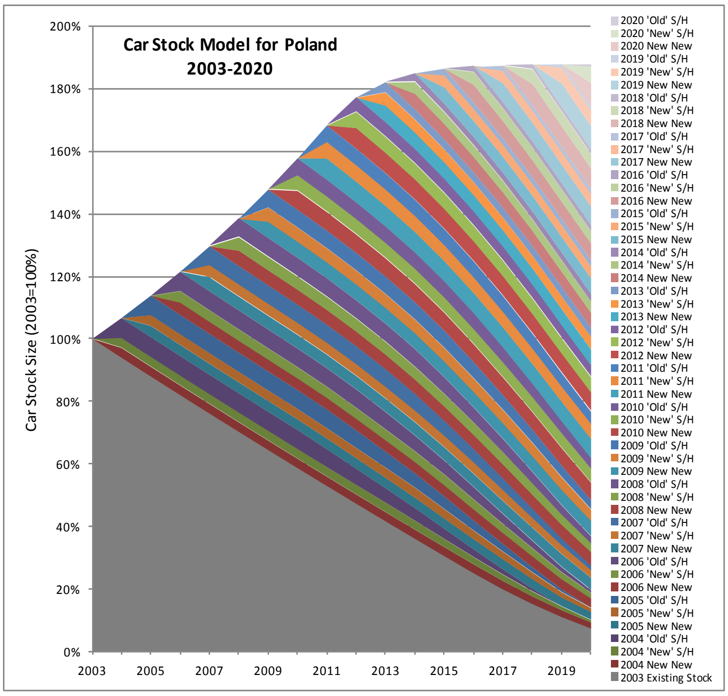
3. Results of Modelling of the Impact of New Car CO_2 Emissions Reductions in Poland

Using the basic data on car stocks and car use from the previous section, a model has been developed as described in Annex 1. This has been applied to each of the CEE countries covered in this report in order to assess future fleet average CO_2 emissions and fuel economy in future years under the range of chosen scenarios. The results of this exercise are set out in the sections that follow.

3.1 Approach to Modelling Fleet Average CO_2 Emissions

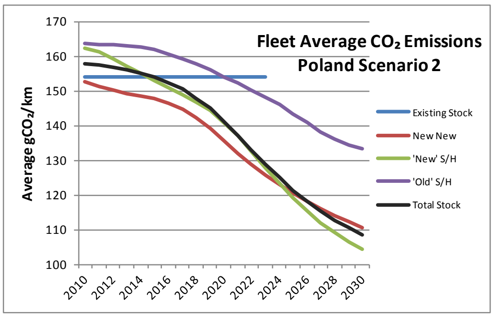
This section uses data presented in Section 2 along with the methodology described in Annex 1 in order to show the impact of the various scenarios for new car CO_2 emissions reductions as calculated for Poland. These calculations reflect in as realistic a way as possible the impacts of both new-bought cars and second-hand imports as they will influence average fleet CO_2 emissions and fuel economy in the years and decades ahead.
As described in greater detail in Annex 1, the model estimates for each year the contribution to total vehicle emissions from each of four 'tranches' of vehicle stock:

- existing vehicles already in the national car fleet in the base year (2003)
- newly purchased cars entering the fleet in each subsequent year
- relatively new cars imported second-hand in each year (up to 5 years old)
- older cars imported second-hand in each year (more than 5 years old, and sometimes more than 10)



The first of these tranches declines progressively in its influence over the whole fleet average as the oldest vehicles are scrapped year by year, or are used progressively less as they get older. For the other categories, calculated numbers of new vehicles are added to the stock each year, thereby changing the calculated average emissions in subsequent years, until they too are scrapped as they reach the end of their useful lives. This process is illustrated for one particular vehicle stock scenario for Poland in the diagram to the left, which illustrates how new tranches of stock contribute to a growing or constant-sized car stock year by year.

Using this method, it is possible to build up a profile of the average CO_2 emissions for each of these tranches over time, reflecting the improved average targets of new vehicles manufactured in each model year. From this, the overall fleet average in any given year can also be derived.



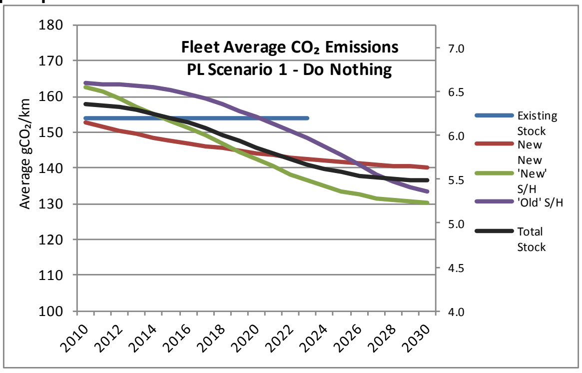
For example, the chart to the right illustrates how the cumulative average CO_2 emissions of each of the four tranches is calculated to evolve under Scenario 2 for future emissions standards for Poland — that is, a scenario in which emissions from new cars are set at 95g/km for 2020, but not required to improve further thereafter. Owing to the lagging effects caused by vehicles already in the fleet and older vehicles continuing to enter the fleet as second-hand imports, it would take some time for the full benefits of the proposed target to be felt. Indeed, fleet average emissions would continue to improve beyond the 2030 threshold of the current analysis, until the full 95g/km target would be approached at some point in the 2030s.

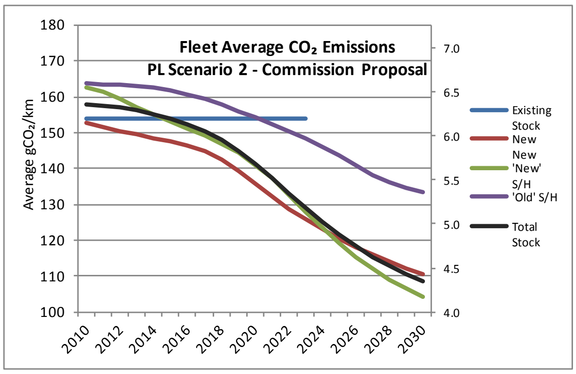
In this example average emissions of the existing stock from 2003 do not improve over time, and those of older second-hand imports would improve less strongly that newer vehicles entering the car stock; however both make a decreasing contribution to the overall total through the 2020s as they are progressively scrapped year on year. Both new purchases within Poland and newer second-hand imports track the overall average fairly closely, but it is noteworthy that the average for imports begins to overtake and fall below that of new purchases towards 2030, owing to the more rapid take-up of the most efficient technologies in the EU 15.

Overall, therefore, this scenario would bring substantial benefits in terms of the overall fuel efficiency of the Polish car fleet, with an average CO_2 rating of little below 160g/km now falling steadily towards 100g/km or less by 2030 and beyond. Other things being equal, this would lead to a comparable reduction in fuel costs for motorists, and reduced demand for oil imports. The results are analysed in greater detail in the next section.

3.2 Modelling Results – Fleet Fuel Efficiency for Poland

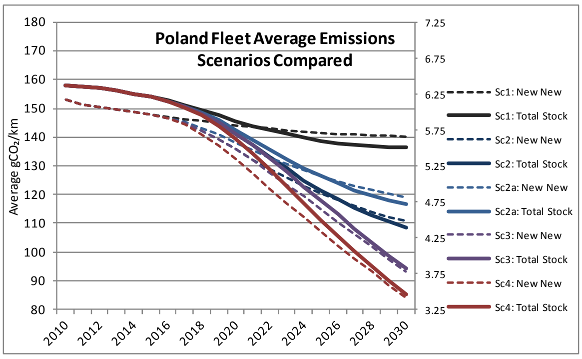
The graphs below illustrate future fleet average CO_2 emissions/fuel efficiency for Poland under both Scenario 1 (the do-nothing scenario) and Scenario 2, which reflects the current proposal for 2020.





In Scenario 1, under which no further targets are imposed beyond those already in place, it can be seen that fleet average CO_2 emissions in Poland are predicted to improve only slowly to approach the 130g target. New purchases within Poland are expected to remain above the target level for the foreseeable future, while imported second-hand cars serve to reduce the average as they reflect the original purchase choices for more efficient vehicles in the EU 15 countries. In contrast, Scenario 2 shows very substantial progress from above 150g now to below 110g by 2030, with further progress towards the 95g target to be expected beyond that date. In this scenario, also, both new cars purchased in Poland and second-hand imports from the EU 15 both contribute in almost equal measure to the continuing improvement.

The next chart outlines the trajectory of average CO_2 emissions for the Polish car fleet under each of the five scenarios set out above. This illustrates that, if no further target was set beyond the 130g/km already agreed for 2015, the Polish average would improve only very slowly and to a small degree relative to the current figure. In contrast, the more ambitious scenarios could develop a very substantial improvement in fleet CO_2 emissions and hence fuel economy out to 2030 and beyond. Looking at the results in more detail, the table below summarises the benefits of tighter standards.



From these it can be seen that:

- the do nothing scenario would allow improvements already in the pipeline to flow through into the Polish car fleet gradually, resulting in a very small average improvement in car fuel consumption over the next two decades.
- The 95g/km proposal for 2020 (Scenario 2) is sufficient to bring significant improvements, amounting to a better than 10% improvement in fleet average fuel economy by that date. This would rise to more than 20 or 30% improvement up to 2030. These benefits are correspondingly reduced if the proposal is allowed to be weakened (scenario 2a), for example by including large provisions for super credits in the 2020 proposal.
- In contrast, the more ambitious Scenarios 3 and 4 offer sustained and continuous improvements, amounting to a reduction in fuel consumption by more than a quarter in 2025, and much more beyond this.

Scenario	2015	2020	2025	2030
	Fleet Average Fuel Consumption (ℓ/100km)			
Sc1: Do Nothing	6.2	5.9	5.6	5.5
Sc2: Commission Proposal	6.2	5.7	4.9	4.4
Sc2a: Supercredits	6.2	5.7	5.1	4.7
Sc3: Continuing Progress	6.2	5.7	4.8	3.8
Sc4: Ambitious Reductions	6.2	5.6	4.5	3.4
	Change in CO_2/Fuel Consumption relative to 2010			
Sc1: Do Nothing	-2.5%	-7.7%	-12.1%	-13.6%
Sc2: Commission Proposal	-2.5%	-10.5%	-23.1%	-31.3%
Sc2a: Supercredits	-2.5%	-9.7%	-20.0%	-26.3%
Sc3: Continuing Progress	-2.5%	-10.5%	-25.3%	-40.4%
Sc4: Ambitious Reductions	-2.5%	-11.7%	-29.6%	-46.0%

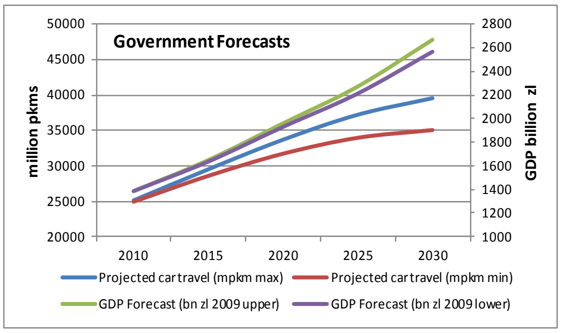
Three key findings emerge:

- Improvements already in the pipeline to EU fleet average fuel consumption should bring some benefits to the Polish fleet in improved fuel economy over the next decade; but the change will be relatively small and quite slow.

- While the benefits of pressing ahead with the proposed targets are very significant in Scenario 2, Scenario 2a illustrates that the benefits will be correspondingly reduced through the 2020s and beyond if excessive flexibilities are allowed to weaken that target.
- If further targets are imposed for the years 2025 and beyond, as illustrated in Scenarios 3 and 4, substantially greater benefits would be apparent by the year 2030. In the most ambitious Scenario 4, indeed, average fleet CO_2 emissions would be halved and fleet average fuel economy would double from current levels soon after 2030. Under both of these scenarios, further substantial improvements in fleet fuel economy can be anticipated in 2020 and beyond.

3.3 Projected Future Car Traffic Levels

The sections which follow will translate improvements in CO_2 emissions into fuel cost savings and oil import demand reductions for Polish motorists and the Polish economy respectively. To do this, it is necessary to reflect official forecasts of future GDP and likely traffic growth (Burnewicza, 2010) as well as the fuel economy figures calculated above.



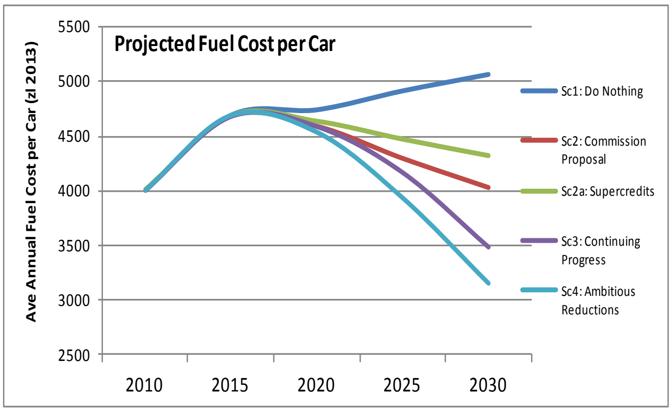
As the chart to the left illustrates, these envisage a steady increase in national income year on year out to 2030 and beyond. Although the Polish economy has in reality suffered setbacks owing to the economic difficulties in recent years, as have most others in Europe, this projection of steady future growth provides a reasonable basis for future forecasts, given that per capita GDP in Poland is as yet substantially below the EU average. Car travel is projected to grow at a similar rate in the coming years, but with some decoupling of travel growth from GDP after 2020 as car ownership and distances travelled approach saturation levels. These forecasts are broadly consistent with experiences in Western Europe in recent decades.

Note that, for the purpose of this modelling exercise, vehicle kilometres are assumed to increase in line with the forecasts of passenger kilometres. This is arguably a conservative assumption, as car load factors are likely to decrease over time as car ownership and distances driven increase. This pattern is already apparent in the Czech Republic, for example. Again for the purposes of the modelling, the central traffic case is based on a midpoint between the maximum and minimum from the official forecasts.

3.4 Projected Impact of Emissions Reductions on Fuel Costs

Combining these traffic forecasts with the modelling results on CO_2 emissions and fleet fuel efficiency, we can now calculate future fuel costs for driving a typical car in Poland. These take account of likely future increases in the size of the total car stock, but also of the projected growth in probable distances driven. Taken together, these imply an increase in availability of passenger cars for individual households, but at the same time, an increase in the average distance driven in each car.

Official national energy statistics (Poland CSO, 2012b) estimate that in 2009, the average cost of road fuel per car was somewhat below 3,500zl per year. However, at current fuel prices (taken from e-petrol.com.pl) it appears likely that this figure has now risen to more than 4,500zl per year. This is substantially more than the typical total annual expenditure on transport in Poland, and more than in all but the top quintile of households (Poland CSO, 2012a). This suggests that many motorists must either restrict their total distance driven to well below the average in order to keep their costs manageable, or they are spending much more than the average national share of household income on filling up their cars.



The chart to the left illustrates that the modest improvements that will flow through the Polish car fleet as a result of the current legislation to cut vehicle CO_2 emissions – the do nothing scenario – will be insufficient to avoid a further and continuing increase in average car fuel costs as more fuel is needed to reflect the growing distances driven, even on the assumption of no future increases in the real terms price of fuel.

In contrast, as the table below illustrates, all of the scenarios reflecting a future tightening of standards after 2015 forecast a real terms reduction in fuel costs per car even in spite of the anticipated increase in average distance driven:

- Real costs would fall modestly even by 2020 in all these scenarios, although the reduction would be very slight if the 2020 proposals were allowed to be watered down by super credits.
- Scenario 2 offers a nearly 10% reduction in real fuel costs per car by 2025 even when account is taken of the likely increase in distance driven. This benefit approximately doubles by 2030.
- Again, the more ambitious scenarios show continuing improvements beyond 2020, with real cuts in annual fuel costs making driving more affordable to the increasing numbers of motorists.

Scenario	2015	2020	2025	2030
	Average Annual Fuel Cost per car (zl 2013)			
Sc1: Do Nothing	4687	4735	4908	5058
Sc2: Commission Proposal	4687	4593	4296	4026
Sc2a: Supercredits	4687	4633	4469	4318
Sc3: Continuing Progress	4687	4593	4171	3488
Sc4: Ambitious Reductions	4687	4533	3935	3160
	Change in Cost relative to 2010			
Sc1: Do Nothing	+17.0%	+1.0%	+3.7%	+3.1%
Sc2: Commission Proposal	+17.0%	-2.0%	-9.3%	-18.0%
Sc2a: Supercredits	+17.0%	-1.1%	-5.6%	-12.0%
Sc3: Continuing Progress	+17.0%	-2.0%	-11.9%	-28.9%
Sc4: Ambitious Reductions	+17.0%	-3.3%	-16.9%	-35.6%

This would represent a real benefit to Polish motorists, as car running costs are currently high in relation to typical household incomes. If current proposals for 2020 are allowed to be watered down through wide scale application of super credits and other flexibilities, this benefit will be relatively small. However, if the proposals are applied in full, and indeed extended beyond 2020, then the benefits in terms of real car running costs could be substantial. As with the earlier scenarios, the benefits would continue to accrue well beyond 2030, particularly in the more ambitious Scenarios 3 and 4.

Fuel Costs and the Rebound Effect

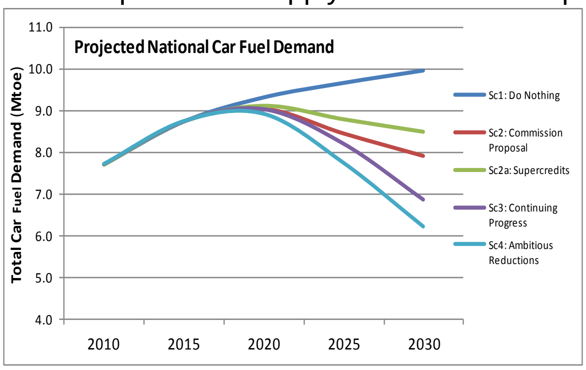
In the UK, the Energy Research Centre has conducted extensive research on the size of the rebound effect in Europe and North America. That is, they estimated to what extent, when fuel prices fall as a result either of falling prices or of improved fuel efficiency, consumers respond by using more fuel and hence the services that it brings them rather than just enjoying a reduction in expenditure.

They concluded (Sorrell, 2007) that for transport, the rebound effect was always at least 10%, and possibly as much as 30% in some cases. That is, they concluded that if fuel costs fall by 10% as a result of improving fuel efficiency, then at least 1% of that gain will be expressed as an increasing demand for road fuels. This result was based largely on analyses conducted in Western Europe, so it is not certain that the conclusion that would hold good for Poland, for example.

Nonetheless, it is reasonable to assume that if the fuel economy of vehicles in Poland improves in the future, then some of the benefit will be expressed as an increase in distance driven. However, a significant majority of the benefit would be taken as a reduction in average fuel costs.

3.5 Projected Impact of Emissions Reductions on Future National Fuel Demand

It is also possible to apply the modelled improvements in fuel economy/efficiency alongside projections of future car kilometres to project likely future fuel demand from cars for the Polish economy as a whole.



These illustrate that efficiency improvements already in the pipeline will have only a limited effect in curbing total fuel demand in the face of increasing car traffic, such that the total demand for road fuels will increase by about a third from 2010 levels by 2030. This would represent a continuing increase in demand for imported oil-based fuels, accompanied by a negative impact upon the national balance of trade. In contrast, the proposed tightening of standards from 2015 should be sufficient to curb the growth in demand and to actually bring it back closer to 2010 levels. Further increases in the stringency of standards beyond 2020 could reduce future road fuel demand to well below the levels experienced in 2020, or even 2010.

Scenario	2015	2020	2025	2030
	Total Car Fuel Demand (Mtoe pa)			
Sc1: Do Nothing	8.75	9.33	9.67	9.97
Sc2: Commission Proposal	8.75	9.05	8.46	7.93
Sc2a: Supercredits	8.75	9.12	8.80	8.51
Sc3: Continuing Progress	8.75	9.05	8.22	6.87
Sc4: Ambitious Reductions	8.75	8.93	7.75	6.23
	Change in Demand relative to 2010			
Sc1: Do Nothing	+13.3%	+20.7%	+25.2%	+29.0%
Sc2: Commission Proposal	+13.3%	+17.1%	+9.5%	+2.7%
Sc2a: Supercredits	+13.3%	+18.1%	+14.0%	+10.1%
Sc3: Continuing Progress	+13.3%	+17.1%	+6.4%	-11.1%
Sc4: Ambitious Reductions	+13.3%	+15.5%	+0.4%	-19.4%

As in other respects, these improvements would be expected to be felt well beyond 2030, and could represent a substantial reduction in Poland's dependency upon imported petroleum-based road fuels and costs to the national economy.

Transport and Oil Dependency in Poland

In 2011, the International Energy Agency noted that:

> “Oil remains the second biggest energy source in Poland, representing 26% of the country’s total primary energy supply in 2009. Poland’s oil demand increased from 411 kb/d in 2000 to 535 kb/d in 2009, with an annual average growth rate of 3%. The transport sector accounted for around 60% of the total oil consumption in Poland in 2009. With a small indigenous oil production, almost all of the crude oil used in Poland is imported. ... Russia is the single largest source of crude oil imports and provided about 94% of the total in 2009.”

Source: International Energy Agency (2011)

3.6 Impact on National CO_2 Emissions

The Polish government estimated total national CO_2 emissions from cars at approximately 19.5Mt for 2008 (Poland CSO, 2011b), but they have grown steadily since then. Modelling undertaken for this report estimated that the total would have reached 21.8Mt in 2010, and will rise to around 24.7Mt in 2015.

As the table below illustrates, future decisions on car fuel economy could have a major impact on national CO_2 emissions. Under the do nothing scenario, emissions would continue to rise steadily to over 28Mt CO_2 per year by 2030, whereas the Commission’s proposal for 2020 would have an rapid impact on total emissions by 2020 and beyond, and return them more or less to 2010 levels by 2030.

If progress on cutting emissions continues beyond 2020, then we could see emissions cut to close to 2010 levels by 2025, with significant cuts to below 2010 levels by 2030.

Scenario	2015	2020	2025	2030
	Total Car CO_2 Emissions (Mt pa)			
Sc1: Do Nothing	24.7	26.4	27.3	28.2
Sc2: Commission Proposal	24.7	25.6	23.9	22.4
Sc2a: Supercredits	24.7	25.8	24.9	24.1
Sc3: Continuing Progress	24.7	25.6	23.2	19.4
Sc4: Ambitious Reductions	24.7	25.2	21.9	17.6
	Change in CO_2 Emissions (Mt pa) relative to 2010			
Sc1: Do Nothing	+2.9	+4.5	+5.5	+6.3
Sc2: Commission Proposal	+2.9	+3.7	+2.1	+0.6
Sc2a: Supercredits	+2.9	+4.0	+3.1	+2.2
Sc3: Continuing Progress	+2.9	+3.7	+1.4	-2.4
Sc4: Ambitious Reductions	+2.9	+3.4	+0.1	-4.2

4. Overall Conclusions

The main conclusions to be drawn from the above analysis are as follows:

- Poland above all amongst the CEE countries being studied is experiencing a rapid increase in private car ownership and use, and this is projected to continue into the future.
- Average distances driven in each car are also likely to increase, leading to growing demand for road fuels if fuel economy is not improved.
- Other things being equal, this will lead to significantly increase fuel costs for motorists, and growing demand for imported fuels.
- Regarding average car fuel economy, the do nothing scenario would result in only a very small average improvement in car fuel consumption over the next two decades, whereas the Commission's 95g/km proposal for 2020 is sufficient to bring a better than 10% improvement in fleet average fuel economy by that date. In contrast, the more ambitious Scenarios 3 and 4 offer sustained and continuous improvements, amounting to a reduction in fuel consumption by more than a quarter in 2025, and much more beyond this. Average car fuel consumption would fall to below 4 litres/100km by 2030.
- Average annual car fuel costs are now estimated at around 4,500zl per year, which is a substantial share of income for most households. Under the do nothing scenario this would rise further in future years, whereas the Commission proposal would bring immediate reductions amounting to several hundred zlotys per year from current levels. More ambitious scenarios would extend this benefit further, bringing the average down to around 4,000zl by 2025, and nearer 3,000zl beyond that date.
- The same is true for national road fuel demand, with cars likely to require around 10Mtoe of imported fuels each year by 2030 under the do nothing scenario. The Commission's current proposal for 2020 is already sufficient to bring demand back down to around current levels in the medium term, whereas continuing progress in tightening fuel economy standards would result in an absolute reduction in road fuel demand from current levels of several million tonnes by 2025.
- Future decisions on car fuel economy could also have a major impact on national CO_2 emissions. Under the do nothing scenario, emissions from cars would continue to rise steadily to over 28Mt CO_2 per year by 2030, whereas the Commission's proposal for 2020 would have an rapid impact on total emissions by 2020 and beyond, and return them more or less to 2010 levels by 2030. With continuing progress on cutting emissions beyond 2020, we could see emissions return to close to 2010 levels by 2025, with significant cuts below this by 2030.
- In all respects, allowing the Commission's proposals for 2020 to be watered down through excessive use of super credits would significantly reduce the benefits on offer from more ambitious targets.
- In spite of the high percentage of second-hand car imports into the Polish fleet, therefore, more stringent new car CO_2 emissions standards have the potential to bring about a substantial improvement in fleet fuel economy in Poland and hence to reduce the demand for road fuels.
- This is potentially of great strategic importance for Polish motorists, and for Poland's future dependence on imported oil.

- Future increases in the distance driven per vehicle are very possible and would further exacerbate the growing demand for imported fuels; equally, there are substantial risks of future oil price rises. In both cases, the financial demands on Polish motorists and the Polish economy would be correspondingly increased, while the benefits of improving fuel economy would be all the more significant, and could more than counteract these risks.
- There are numerous uncertainties in these forecasts, but a structured sensitivity analysis demonstrates that these conclusions are robust in the face of the uncertainties, and that the numerous benefits of pursuing tighter CO_2 emissions and fuel economy standards are very clear.

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Annex 1: CEE Fuel and CO2 Study: Methodology

A1.1 Introduction

The EU's Cars and CO_2 Regulation of 2009 set a tailpipe standard for carbon dioxide (CO_2) emissions from cars for 2015, and a more stringent standard of 95g/km is under consideration for the year 2020. The existing regulation has already resulted in significant improvements in the average CO_2 performance of new cars sold in the EU, and corresponding improvements in fuel economy. The purpose of this study is to calculate the savings in fuel costs which typical motorists will enjoy in Central and Eastern European (CEE) Member States under a range of assumptions as to the stringency of future standards. The various scenarios are set out in the main report and summarised below; the results illustrate that significant cost savings would be available to all motorists if stringent CO_2 standards are pursued.

The study focuses on the fuel consumption of cars covered by the regulation and the fuel costs to their drivers – i.e. consumption of road fuels excluding those burned by vans, buses and heavy-duty diesel vehicles. The methodology applied is based on a study of the EU15 countries (i.e. the 'old' member states) modelled individually: EU10 countries were not included at that time as they present some distinctive challenges as outlined in the main report. This study uses an enhanced methodology to deal with these issues, and to present results for the largest CEE countries and some others for which data are good.

A1.2 Methodology

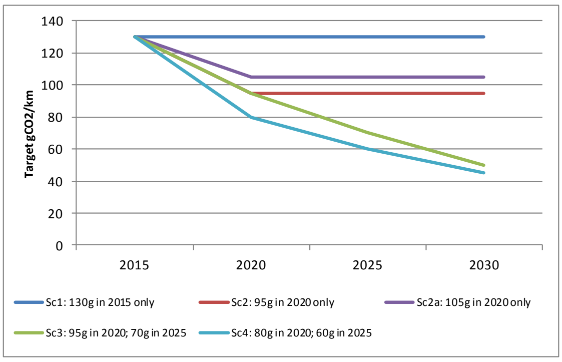
The overall purpose of this exercise is to calculate the amount of fuel and hence of fuel cost that motorists across CEE might save in the future as a result of legislation to reduce new car carbon dioxide emissions. To do this, a modelling exercise has been undertaken covering the following five main tasks:

- establishing a set of scenarios of possible future CO_2 reduction targets;
- calculating how these will apply to each member state;
- reflecting the specific characteristics of national car fleets in the model;
- modelling the impact of these scenarios on car fleet average CO_2 emissions reductions; and
- translating these reductions into fuel and cost savings in each member state.

The rest of this section briefly describes each of these processes in turn.

Establishing a Set of Scenarios of Possible Future CO_2 Reduction Targets

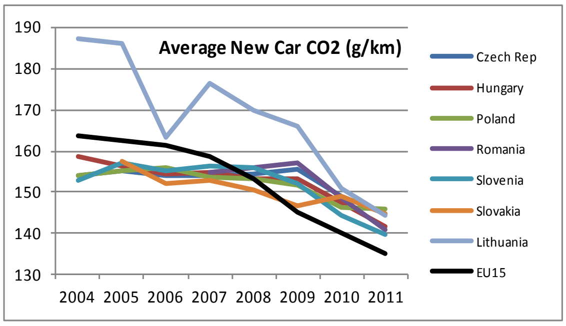
A set of five scenarios of possible future CO_2 reduction targets were established for the whole of the EU, and these are set out in the main report. They reflect the current position, future expectations, and the technical potential for further emissions reductions in the future. Note that in Scenarios 3 and 4, further broadly linear reductions beyond the specified dates are also assumed.



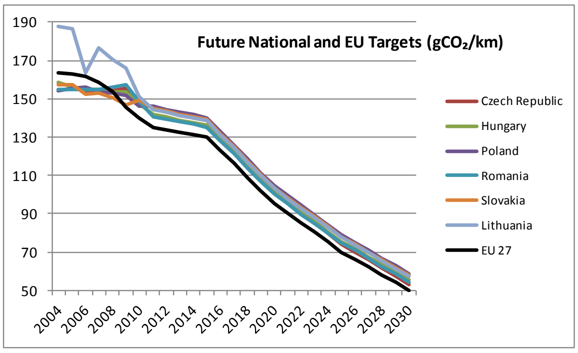
These five scenarios can be depicted graphically as follows:

Calculating How the Targets Will Apply to Each CEE Member State

All Member States in CEE have made progress in reducing their new car average CO_2 emissions over the past decade. As this graphic illustrates, most began from rather similar starting points and have made progress towards their positions in 2011, the latest year for which data are available. It can be seen, however, that while all the countries shown have made progress in reducing the average CO_2 emissions from new cars, this progress has been less rapid than in EU 15. As a result, while new cars bought in CEE in 2004 were typically more efficient than the EU average, this position had been reversed by 2011.



The target scenarios referred to above refer only to the EU as a whole, not to each Member State individually. Hence we can expect that future progress will not be totally identical in all member states either. It is therefore likely in particular that those states which currently have the highest new-car averages will continue to do so into the future, and that the burden of meeting future targets will not be exactly equal in each member state. On the other hand, it seems reasonable to expect that the greatest progress should be made in the states with the highest emissions at present, leaving less to be done in those countries where emissions are already quite low.



To reflect this, the model developed for this study imposes a degree of ‘contraction and convergence’ between the targets of the member states but also reflects their different starting points. The figure to the left illustrates how this has been applied in one of the five scenarios set out above, such that national targets converge while ensuring that the overall EU average target is met for all the 27 member states together.

Reflecting Car Market Conditions in CEE

The model used in this study, in common with most other stock turnover models in Europe, was originally designed to reflect the market conditions in EU 15 countries.

More specifically, key features of these markets include:

- a relatively modern car stock, fairly evenly distributed in age;
- overall levels of vehicle stock and mileage driven are broadly stable over time;
- additional cars are typically purchased as new from the manufacturers to replace vehicles that are scrapped at the end of their useful lives;
- car stocks in most member states are in a broadly similar state of development and with similar levels of car ownership and use.

In contrast, car markets in CEE have a number of distinctive characteristics, as follows:

- an inheritance of an aged car stock;

- rapidly rising levels of car ownership;
- new car purchases supplemented by substantial numbers of used cars imported, primarily from EU 15 countries;
- car stock conditions in member states in very different stages of development.

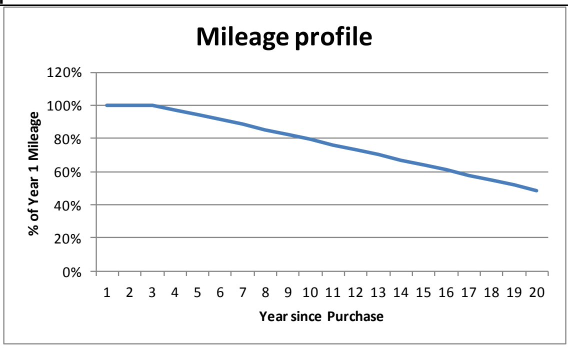
These characteristics have required some specific modifications to the standard methodology used to reflect these conditions realistically and to model the impact of incoming vehicles upon the average CO_2 emissions and fuel efficiency of the total national car stock accurately. These new developments are described in the sections that follow.

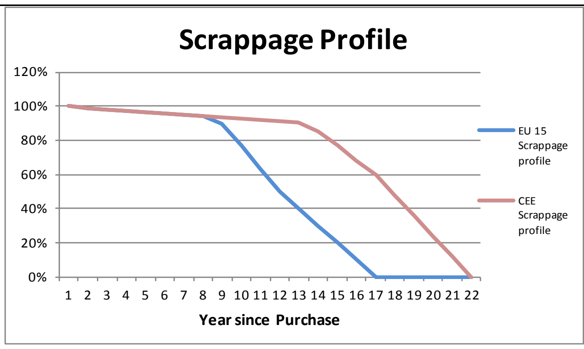
Modelling the Impact of New Vehicles on the Total Vehicle Stock
A key parameter for determining fleet fuel economy and average CO_2 emissions is historical and future average fuel economy of new vehicles entering the fleet. The official figures on this (based on CO_2 emissions) are good for EU 15 from 2001 onwards, and for most CEE countries from 2004. Vehicles entering the fleet prior to 2001 were assumed to have a fuel economy equal to that in 2001, as there was little or no improvement in average fuel economy prior to that date.

Each year, a certain percentage of all the vehicles in national car fleet are scrapped (and some are exported or imported – see below), and their place is taken by new vehicles. Where vehicle characteristics are changing over time – in this case, their average CO_2 emissions are reducing and are required to be reduced further – a stock turnover model is needed to calculate how much impact each model year is having on the overall fleet average emissions at any given time, and hence how fast the overall emissions profile is improving.

This study required the development of a new stock turnover model capable of reflecting conditions in each Member State and covering data from 2001 (when differentiated CO_2 data for each Member State were first reported) through to the end modelling year (2030). This followed the same basic approach as used in previous similar models created by the author, but was generalised in order to be able to reflect the different conditions in the different member states.

In this model, the contribution of each model year to the total mileage travelled in a given calendar year subsequently is determined by two profiles which can be multiplied together to give the total contribution to the total distance driven: a mileage profile and a scrappage profile.

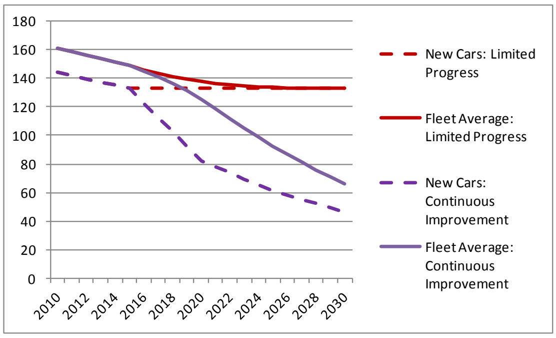




As shown, the mileage profile reflects the fact that most cars are used to their maximum for about their first three years of use: after this they are commonly sold on second hand to private owners, from which time their annual mileage declines to about half of its initial value by the end of vehicle life. These conditions are known to be fairly typical in EU 15 countries, but have been applied equally to the CEE countries in the absence of more specific information.

The scrappage profile reflects how long vehicles typically stay in the vehicle fleet. In EU 15, the scrappage rate is typically very low (<1% e.g. for write-offs after accidents) for approximately the first nine years of life; then about half are scrapped by their twelfth year; with the rest being removed in a rather longer 'tail' out to 15 or 16 years. On average, a car in Western Europe is typically about 13 years old when scrapped or exported. However, the evidence available suggests that cars in CEE are typically retained in service for much longer than is usual in Western Europe. Hence an alternative scrappage profile has been developed and applied in this model, as shown in the right-hand chart above, wherein cars typically remain in use for 20 years or more.

Combining these two profiles then gives a realistic picture of what contribution new vehicles from a given model year will make to the total distance driven in each year thereafter. These values are based on detailed UK data and other data sources for around Western Europe, which confirms that there is some variation from country to country and year-to-year, but that the pattern is similar throughout the EU15 and over time. In the modified form described above, a similar approach is applied in CEE.



When emissions levels are being reduced, the fleet average emissions in a given year will always lag behind those of new cars entering the stock. For example, if 10% of the car fleet is replaced with new cars which are 10gCO_2/km better than the fleet average, they will only improve the fleet average by about 1 g/km overall. If the average emissions of new cars entering the fleet levelled off and remained constant over some years, then the fleet average would eventually 'catch up' the new car average. However, if the improvement in new car emissions performance is continuous, the fleet average follows a similar emissions profile over time, but always lags behind it. This is illustrated in the graph above.

Modelling the Impact of Second Hand Car Imports on Car Fleet CO_2 Emissions in CEE

As noted, second-hand car imports are an important feature of some at least of the car markets in CEE countries, and these need to be modelled separately. For modelling purposes, they can be treated in a similar way to new cars entering the stock, but they differ from genuinely new or 'new new' cars in two critical respects:

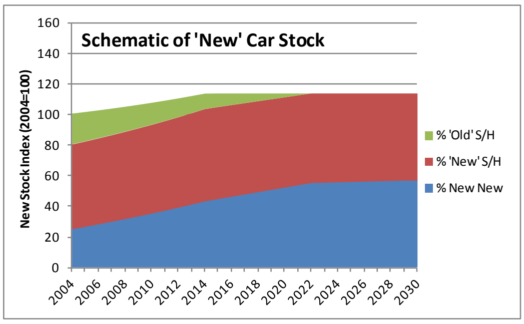
- By definition they are not new, so their remaining useful life is likely to be correspondingly less than that of a 'new new' car entering the fleet. Also, having been manufactured some years in the past, they are likely to have been subject to a less stringent standard of CO_2 emissions performance, and hence are likely to be less fuel efficient than a similar car bought new.
- They will have been originally purchased under the market conditions prevailing in the country from which they were imported, and this too is likely to influence their CO_2 performance and fuel economy.

In times of rapidly-improving fuel economy, it is likely that second-hand imports will have poorer fuel efficiency than their equivalents bought new, but this is not necessarily the case; as noted, average CO_2 emissions of new cars in some EU 15 states are better than those of new-bought cars in CEE. Hence it is possible that relatively new second-hand imports may offer as good or better fuel economy than a typical car bought new in the same country in the same year.

As discussed in the main report, historically many of the cars imported into CEE were already quite old. There is however some evidence to suggest that as time goes on, the average age of second-hand imports is decreasing. Modelling this trend is potentially very complex, available data are poor, and predicting future trends is problematic. Therefore for the purpose of this exercise, second-hand imports are divided into two types: relatively new second-hand cars, with an average age at import of 3 to 4 years; and much older cars with an average age assumed to be eight years at the time of import. The split between 'new second-hand' and 'old second-hand' at the start of the modelling period is based on historical data, and it is assumed that over time the split will develop in favour of the newer second-hand imports.

Modelling the Growth in Car Stock

As described in the main text, total car stocks are growing in all CEE countries to one extent or another. This occurs when the number of cars added to the stock significantly exceeds the number scrapped in any given year. This is modelled by adding new cars at a greater rate, both new- bought and second-hand imports, in line with historic trends. However, it cannot be assumed that such trends will continue indefinitely, as some countries are already approaching what is expected to be the saturation level for car ownership. In these cases, new cars are added only at a rate sufficient to replenish the stock each year once the saturation level is reached.



The chart on the left is a schematic illustration of how these changes are modelled over time. In this illustration, car ownership saturation level is reached at around 2015, and imports of the older second-hand cars are eliminated soon after this date. In this instance, the proportion of cars bought new continues to grow until it reaches approximately half of the total. Clearly we cannot know with any great precision how any of these aspects of the car fleet will actually develop in any given country, so all of these assumptions can be varied both to reflect the current situation in each individual country, and to test the sensitivity of assumptions about future stock development.

The model developed in this way was then applied for each member state, both to its historic emissions performance and to each of the five future scenarios in turn. This produced a profile of fleet average CO_2 emissions year by year and the degree of improvement relative to the baseline year for each of the five emissions scenarios were then calculated. The results are presented in the main report.

A1.3 Calculating the Fuel Cost Savings

EU statistics were used to determine the actual average fuel consumption per car in each country. These vary from country to country reflecting the composition of the car fleet, distances driven and road conditions; however in a few cases the amount consumed seemed implausibly low or high, and in these cases the numbers were adjusted towards the average. These numbers were then multiplied by post-tax fuel prices in each country to give an estimate of current average fuel costs, and these figures are reconciled with available data on national car expenditure costs. For each country and scenario, it was then possible to calculate the cost savings that would arise from improved fuel economy for a typical main driver of an average car.

Note that the results assume no future increase in the distance driven per vehicle per driver. As discussed in the main report, there is no clear evidence that this is occurring at present. This is not necessarily a prediction for the future, however, but allows cost savings to be presented on an ‘other things being equal’ basis. Results are also presented in money of today, and with tax rates held constant.

A1.4 Assessing Uncertainties and Sensitivities

In the paragraphs above, a number of uncertainties have been highlighted where hard data are scarce, or where the likely path of future developments is particularly unclear. In order to assess the sensitivity of the results and conclusions of the report to these various uncertainties, a structured sensitivity analysis was also performed on the model used.
The approach and results of this analysis are set out in Annex 2.

Annex 2: CEE Fuel and CO2 Study: Sensitivity Analysis

A2.1 Introduction – Why Carry Out a Sensitivity Analysis?

For this report, every effort has been made to develop a model of car stocks in CEE countries that is as robust and realistic as possible. Equally, realistic choices of input variables have been made on the basis of the best available data, and reasonable assumptions have been proposed in order to reflect how certain key trends will develop in future years. However, many uncertainties remain, and some of the most important ones have been highlighted in earlier parts of this report. Any attempt to model an extremely complex system is inevitably subject to some degree of uncertainty, so the purpose of a sensitivity analysis such as this is to illustrate how sensitive the conclusions of the report are to changes in some of the input variables. This annex reports the conclusions of this analysis.

On the other hand, it is important to bear in mind that the forecasts presented here are not a prediction of the future. In reality, such forecasts hardly ever do predict future outcomes with complete accuracy, because there are many variables to be taken into account, and there can be no certainty as to how some of the key trends will pan out in future years. For example, will second-hand car imports fall in future years, and will they be younger on average than they are now?

However, this is not to argue that forecasts such as these are pointless or too uncertain to be useful. On the contrary, their purpose is to illustrate how certain outcomes may develop in the future in the face of a range of alternative scenarios (in this case, future emissions standards), and how robust the conclusions drawn can be in the face of inevitable uncertainty.

A2.2 Key Variables Tested in the Sensitivity Analysis

A number of variables are clearly critical in determining how future emission standards will impact upon actual emissions and fuel consumption in any given country in future years. For example:

- ***How rapidly will car stocks continue to grow in each country, and what is the limit to this growth?*** As noted in the main report, car ownership levels are increasing fairly steadily across most CEE countries; but will this continue at current rates, and at what point will ownership saturation be reached?
- ***To what extent will additional demand be filled by brand-new cars, and to what extent by second-hand imports?*** In some CEE countries, second-hand imports are an important element in satisfying the demand for additional cars alongside brand-new purchases. However, it is not clear how long and to what extent this will continue to be the case in future years. Also, the age profile of second-hand imports is an important determinant of future fuel economy.
- ***What will be the relationship between purchase choices in a given country and the overall EU standards?*** As noted, the average emissions of new car purchases across CEE are currently above the EU average; but it is less clear whether this will continue to be the case in future years.
- ***What will be the relationship between actual average new car emissions and the EU standards that are set?*** The average emissions of new car purchases across the EU are typically assumed to match exactly to the standards set for target years. However, manufacturers cannot control the average of new cars sold very

precisely, so they will err on the side of overachieving the targets in order to avoid punitive fines. Recent results also suggest that they may exceed short-term targets in order to put themselves on course to meet more challenging targets further ahead.

- ***How much will each car be used, and for how long before it is decommissioned?*** The existing car stock in most CEE countries is quite old on average compared to most of those in Western Europe, and so too are some of the cars imported second-hand**.** It seems quite likely that, as more and newer cars enter the national fleets and become available to buy, and as the population becomes more affluent, more of these older cars will begin to be scrapped. However, it is unclear to what extent or at what average age this will happen.
- ***How will the price of fuel change over time, and what influence will this have upon driver behaviour?*** The cost of fuel for passenger cars is already high in most CEE countries relative to average household incomes. As global demand for fuels continues to grow while known sources become more constrained, it seems quite likely that fuel prices will rise further in real terms in the future.
- ***Will motorists in CEE countries drive farther in future as average incomes increase?*** The distances driven by the average motorist in most CEE countries continues to be well below the levels typical of the EU 15. It may be that there are structural differences in the economies and societies of these countries which dictate that the averages will remain relatively low; alternatively, however, it is quite possible that distances driven will converge with those of EU 15 over time as other circumstances change.
-

Of course we cannot answer any of these questions with any certainty, but we can examine how much a change from the values assumed in our central case will impact upon the results. Where the impact is large, we have to recognise that the conclusions must be tempered with an understanding of the uncertainty surrounding the way in which a particular variable will develop in the future. Where the impact is small, however, we can have confidence that our conclusions are robust in the face of possible variations in the input assumptions.

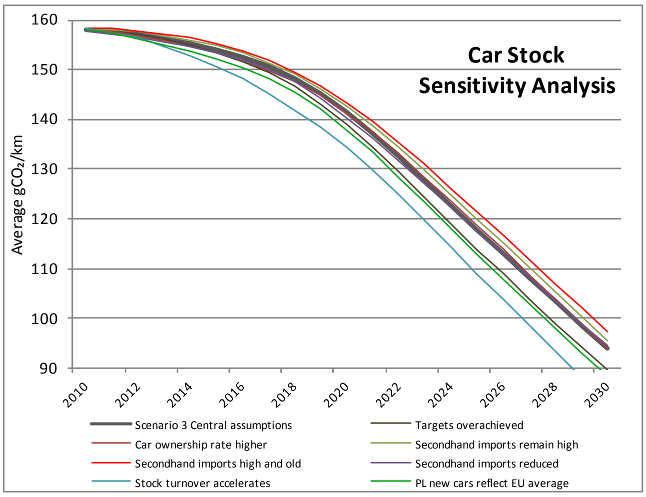
In the table below, the key variables tested in this analysis are listed. Their likely impacts upon future CO_2 emissions and fuel consumption are outlined, and the range of variation that was tested is indicated.

Sensitivity Tested	Key Impact On: Ave CO_2	Cost per Car	Total Fuel Used	Nature of Impact	Variable Adjusted
CO_2 targets overachieved	✓			Directly affects average CO_2 emissions rate of new cars	New car average set to 95% of targets for 2015 onwards
Expected car ownership rate higher	✓			Affects rate of introduction and proportion of newer vehicles	Saturation level increased 550→600 cars/000
Proportion of secondhand imports remains high	✓			Delays or dilutes impact of improved standards	Still 60% S/H in 2030
Proportion and age of secondhand imports remain high	✓			Delays and dilutes impact of improved standards	70% S/H imports in 2030, o/w 30% >5yrs old
Proportion of secondhand imports reduces more rapidly	✓			Accelerates or accentuates impact of improved standards	Only 20% S/H imports by 2030
Stock turnover accelerates	✓			Accelerates and accentuates impact of improved standards	EU 15 turnover rates applied
Polish new car purchases reflect EU average	✓			If new sales reflected EU average, overall emissions would fall	PL new car average = EU average
Increase in real price of fuel		✓		Increased cost, but impact partly offset by lower distance driven	Price increased by 20% real terms by 2030
Total distance driven higher than forecast			✓	Direct impact on total fuel consumed	Central forecast +10% by 2030
Total distance driven lower than forecast			✓	Direct impact on total fuel consumed	Central forecast -10% by 2030

In the sections that follow, the results of the sensitivity tests are discussed, grouped according to whether their primary impact is upon fleet average CO_2 emissions, fuel costs or the total of fuel consumed. Clearly, a change in the fuel economy of the fleet will also have an effect on fuel costs and fuel consumed, but these will be largely proportionate to the change in fuel economy, so it is not necessary to replicate the analysis at this level. Conversely, a change in the distance driven per car has only a very indirect effect on the car fleet or its fuel economy characteristics, but will certainly lead to an increase in total fuel consumed.

A2.3 Results of the Sensitivity Analysis

Having determined which parameters and uncertainties were most likely to be important in terms of influencing the results of the analysis and the conclusions drawn, the model was rerun repeatedly for a single emission scenario (in this case, Scenario 3 for Poland) while varying each of the chosen parameters in turn as indicated in the table above and recording the impact of this variation upon the results.



The graph to the left shows the results for changes to the first seven variables, ie those that have the most direct impact upon the future development of the national car stock, and hence upon the average CO_2 emissions of the car fleet as a whole and its fuel economy. From this it can readily be seen that even quite significant changes to the size of the total car stock and to the proportion of second-hand car imports have only relatively minor impacts upon the fleet average emissions. This is because they only change the timing of the impact of future standards to a small extent, but these impacts are still experienced anyway with only a slight acceleration or delay. Even a high proportion of older car imports have relatively small adverse effect on average emissions, as these cars are likely to be driven less far and for less long, and in any case will still offer fuel economy benefits relative to the existing fleet.

In contrast, if new cars purchased in Poland were to reflect the average across the EU as a whole, this would result in a visible improvement in fleet average emissions relative to the central assumptions made for this study. So too would a small but systematic overachievement of the targets that have been set.

The largest improvements in average emissions would be achieved if the rate of stock turnover in Poland, which is currently very slow by the standards of most Western European countries, could be accelerated to the EU average. This would have the effect of accelerating the retirement of the oldest and least efficient vehicles in the fleet, while making space for new cars with lower emissions and better fuel economy . This is not to say that such a change is desirable or even possible: but it does illustrate that the stock turnover rate has an important influence upon fleet average emissions in a scenario where new car standards are improving to a significant degree over time. Although it was not possible to model this in any detail, it is almost certain that the converse is also true: that is, if car stock turnover was to turn out to be even slower than is assumed in the central case in the model, then the benefits of improving new car standards would be further delayed in flowing through to the total car stock.

In the table below, results for all those variables which were analysed, including those that are exogenous to the vehicle stock itself, are summarised in numerical form and compared to the results in the central case.

Sensitivity Case	2015	2020	2025	2030
	Change in CO_2 relative to 2010			
Scenario 3 Central assumptions	-2.5%	-10.5%	-25.3%	-40.4%
Scenario 3 Overachieved	-2.8%	-12.0%	-27.9%	-43.2%
	Change in CO_2 relative to Central Case			
Car ownership rate higher	-0.5%	0.0%	+0.7%	-0.1%
Secondhand imports remain high	+0.5%	+0.9%	+1.8%	+1.5%
Secondhand imports high and old	+0.8%	+1.4%	+3.0%	+3.4%
Secondhand imports reduced	-0.3%	-0.7%	-0.2%	+0.4%
Stock turnover accelerates	-2.2%	-4.9%	-7.5%	-11.4%
PL new cars reflect EU average	-1.1%	-2.4%	-4.3%	-6.0%
	Change in fuel cost relative to Central Case			
Increase in real price of fuel	+4.5%	+9.0%	+13.5%	+18.0%
	Change in total fuel burn relative to Central Case			
Total distance driven higher	+1.5%	+5.0%	+7.5%	+10.0%
Total distance driven lower	-1.5%	-5.0%	-7.5%	-10.0%

A2.4 Overall Conclusions of the Sensitivity Analysis

The table above illustrates that changes in the exogenous variables (i.e. changes in fuel price and traffic growth) could have a much greater impact upon the cost or volume of fuel burned than any of the uncertainties that are endogenous to the stock turnover model itself. That is, the conclusions of the modelling can be seen to be quite robust in the face of uncertainties, and illustrate how an ageing and not particularly efficient car stock would be transformed by the influx of new and more efficient vehicles, providing that EU vehicle standards continue to improve.

Other important changes in the transport system could have a major impact upon the outcomes, and in many cases, these would be detrimental ones.
Conversely, it can be seen that the reductions in emissions and hence in specific fuel demand that would result from the tighter emission standards in Scenario 3 are more than sufficient to counteract major changes in fuel price or traffic levels. Provided that the standards already set for 2015 are met or overachieved (as now seems very likely), modest benefits in fuel economy should already be becoming apparent in terms of Poland's fleet average fuel consumption. Under a more ambitious scenario, these will increase to 10% or more by 2020, and at least 25% by 2025. Even greater reductions can be achieved in the long term.

That is, in the case under consideration, the benefits of tighter standards would more than outweigh any adverse impacts that can be reasonably foreseen, and would therefore have the effect of more than completely counteracting the modelled increases in fuel price or distance driven. Thus improved fuel efficiency would under most foreseeable circumstances provide a valuable ‘insurance policy’ both for nation states and for their motorists in the face of rising fuel costs or increases in the average distances driven.

[i] Average petrol (4,1) and diesel (3,6)