HOW TO MONITOR THE IMPACT OF CO2 EMISSIONS ABATEMENTS POLICIES FOR CARS ?

Dr Didier BOSSEBOEUF
France

ADEME

Abstract :

Cars CO2 emissions are still a major responsible for the rising CO2 emissions of the transport sector despite many efforts experienced by the countries to reduce these emissions. Therefore, it becomes crucial to correctly monitor these trends and to go far beyond the sole inventory of emissions in understanding the main driving forces, which are shaping these emissions trends. Most European countries have set-up voluntarist energy efficiency or CO2 abatement policies towards cars. Their impacts depend on many factors and national context and on their integration in the transport policy in general. The range of used instruments is quite large from support to R&D, regulations, fiscal measures, subsidies to alternative fuels, or more recently voluntary agreement with car manufacturers. To properly monitor the impact of such policies or package of policies, a collaborative process has been set-up under a European Commission and national supports of 16 European countries. Within this framework so called ODYSSEE, a comprehensive methodology through a set of quantitative information has been developed.
Having recalled the main policies launched in the car's sector, this paper will propose a methodology to monitor unitary emissions trends from different perspective. Interpretation of these trends will be carried out related to the implemented policies. A conclusion will be drawn on the advantages and the current limits of such an approach and the necessary complementarity with other approaches.

Introduction

Cars is a key sector when discussing CO2 emissions abatement assessment:

- First of all, it is a sector in which the energy demand is still growing rapidly and pulling the total energy demand. From 1990, the energy demand of transport in the European Union increased by about 1.7% per year against 0.3% per year for industry and 1.3% per year for residential needs and services.
- Secondly, limited energy efficiency actions have been implemented due to the complexity of this sector and the importance of non-technical factors: multiplicity of actors, consumers' preference for cars, special status of cars as a consumer good, etc. In addition, the sectoral transport policy is by far more important in shaping trends than CO2 policies themselves and is generally non-energy saving oriented.
- Finally, this sector is responsible for significant emissions, either from the viewpoint of greenhouse gases and overall environmental concerns, or from that of local emissions in urban areas. Within the transport sector, cars were responsible of more than 48 percent of total CO2 emissions in the EU in 1999.

Therefore, it becomes crucial to correctly monitor these CO2 trends and to go far beyond the sole inventory of emissions. We need to better understand the main driving forces, which are shaping these emissions trends. In that respect, quantitative information can be used with the view of the following objectives :

- To monitor CO2 emissions or energy efficiency trends;
- To evaluate past programmes with an assessment of their impacts on CO_2 emissions;
- To compare the performances among countries.

The **main objective** of this paper is to show what indicators can help policy makers for CO2 strategies evaluation, in particular in illustrating the relationship between the various indicators proposed and related policies. What does each indicator really mean? What question(s) can they really answer? For instance, how to monitor trends of the technical efficiency in relation to voluntary agreement? How to assess the overall CO2 performances in relation to a package of measures.

Having recalled the main policies launched in the car's sector, this paper will propose a methodology to monitor unitary emissions trends from different perspective. Interpretation of these indicators will be carried out related to implemented policies and illustrated with data extracted from the ODYSSEE database. This framework results from a collaborative process of 16 European countries and is supported by the European commission.

1. CO2 abatement policies in the transport sector

The aim of this short section is to broadly present the main types of CO2 abatements or energy efficiency policies that have been launched so far in various countries, rather than to be exhaustive (See IEA 2000, WEC 2001). In the car's sector, classical policies ranging from regulation to economic instruments have been launched with certainly a particular preference for the fiscal tool compared with others sector. A contrario, direct incentives to the drivers or car's owners have not been spread out for evident reasons of cost. These measures affect the technical side and more and more the non-technical side (ISIS-EEC cantique project 2000) of car's performances which are more difficult to tackle. Also, we may consider that in general overall transport policies in particular infrastructure policies have certainly a more important impact on CO2 trends than environmental policies per se. There are many usefull classifications of the policies and we present here a classical one from ranging from regulation to more market-oriented policies.

1) **Regulations**. In fact, very few regulations have been directly set-up for energy efficiency or CO2 abatement purposes : labelling of energy or CO2 performances, standards for unit consumption (CAFE) etc. However, the transport sector rules under a lot of regulations that are launched for other reasons such as safety or environment. A good illustration of this matter is the speed limits for instance. The implementation of mandatory and regular technical controls may be also included in that category.
2) **Support to R&D** generally through direct incentives to car's manufacturer or car devices producers to produce more efficient vehicles or cleaner vehicle (electric, hybrid, NGV, LNG, Hydrogen and fuel cells etc.); support to oil companies or technical centres to produce more efficient fuels can be gathered in that category ;
3) **Technology procurement**: particularly used to develop a new market for alternative fueled vehicules.
4) **Labelling** of energy efficiency or CO2 performances for new vehicles. This label can be mandatory or not.
5) **Voluntary agreement** with cars manufacturers. We refer here to the voluntary agreement (ACEA) between the Commission and the European car manufacturers. It stipulates that

the average CO_2 emission performances for the average cars sold on domestic market should be of 140 g/km de CO_2 in 2008 and can be renegotiated down to 120 gCO_2/km in 2012). This type of instrument is rather new to the sector. It concerns the new vehicles put on the markets ;

6) **Fiscal measures**. A large range of tax regimes in Europe exists, with few of them being environmentally oriented. They impact differently on CO_2 emissions depending on the fact that they apply to car purchases in addition to the normal VAT (varying from 0 to 15000 Euros per car in Europe), on ownership and use and on motors fuels (generally much higher in Europe than in the rest of the world) including the energy taxation and or an additional CO_2 taxation. Road pricing, income tax relief related to journeys to work, company cars fiscal reduction (see Orfeuil 2001) are also fiscal measures which are also very important in the recent context. Analysis shows that it is difficult to find a general rule among European taxation regimes such as a compensation between regimes or a « greenisation » of the taxation.
7) **Support to transport organisation policies** (traffic management, car pooling, urban planning, traffic substitution towards public transport etc.). The funding for environmental concerns to such measures are generally very low compared to others fundings and may only affect the final decision at the margin.
8) **Economic incentives** to accelerate scrappage of old cars taken primarly to reboost the car's sales;
9) **Subsidies for cleaner and efficient cars** which are not so common.

Is also possible to gather these policies in packages oriented to particular targets. Measures 2-3-4-5 and 9 are more targeted towards new cars, the others measures are more oriented to shap emissions of the existing cars. Nevertheless, this distinction can be discussed because for instance, taxation can also, in a longer term, influences car makers to produce more efficienct new vehicles.

Policies for CO_2 abatement mainly rely on energy efficiency or inter-fuel substitution strategies. Clearly, European countries have favoured the fiscal tool in the automotive sector because they are oil importers and the revenue from taxation is an important source of income for the government's budgets. Also concretely, the others measures seem to be more problematic, technically and politically, to be implemented. The adopted mix of policies depends of course on national circumstances of which the size of the countries, the demography and the density of population, the degree of urbanisation or peri-urbanisation, the degree of energy dependency, the economic and fiscal context, the presence of an automotive or public transport sector etc. are the most relevant.

2. How to monitor policies through quantitative information ?

Due to the relative importance of fiscal measures, the assessment of policies in CO_2 emissions or energy demand relies mainly on economic analysis using the concept of elasticities or "budget ratio" which have shown its limits (Goodwin 1988). Nevertheless, we believe that an evaluation based on a more "engineering oriented" approach is needed. In that framework, the nature of the quantitative information to be gathered relies on detailed physical or technico-economic parameters (bottom-up). The following section briefly presents the type of indicators used.

2.1.What kind of indicators

Greenhouse Gases inventories gathers data on emissions. They are not sufficient to identify the impact of measures implemented in each sector. Economic growth, exceptional climate conditions have influence on the level of emissions and may hide the real impact of policies and measures, at least in the short term. The evolution of the sectors emissions result from several driving forces (mainly the level of activity and its structure and the specific carbon efficiency) which are interesting to be evaluated or sorted out. To complement such basic information, additional information is needed through macro economic indicators such as :

- **economic ratios** such as **energy intensities or carbon intensities** are favoured by economists to assess the energy efficiency or CO_2 trends at the level of the whole economy or at the sectoral levels. They are also mostly used by decision-makers and for international comparisons. But, their high level of aggregation unfortunately limits the interpretation. In particular, they do not indicate to which extent changes in these indicators result from voluntary actions towards energy savings or from other factors, not necessarily linked to energy (e.g. structural changes of the fleet). In the case of private transport, the use of economic ratios such as energy intensity has a little value,
- **Technico-economic ratios**, relating an energy consumption or CO_2 emissions to an indicator of activity measured in physical terms (« **unit** » **or** « **specific consumption** »): litre or goe or gCO2 per car, per km, per pass-km, per kg according fuel type and age of cars etc.
- **Energy savings or CO_2 abatement indicators**, that provide an assessment of quantities of energy or CO_2 saved, in absolute values (e.g. Mtoe) or in relative terms.
- To make cross-country comparisons, « **adjusted ratios** » are considered that attempt, as far as possible, to adjust for structural differences between countries. Nevertheless, they are rather limited for cars (impact of climate is negligible on car's CO2 emissions) except controversial issues such as the size of the countries or the population density or the rate of urbanisation and peri-urbanisation.

2.2. Towards a process of selection of a « priority set » of indicators

They are many reasons which can explain the need to carry out an analysis of car emission trends through a variety of indicators :

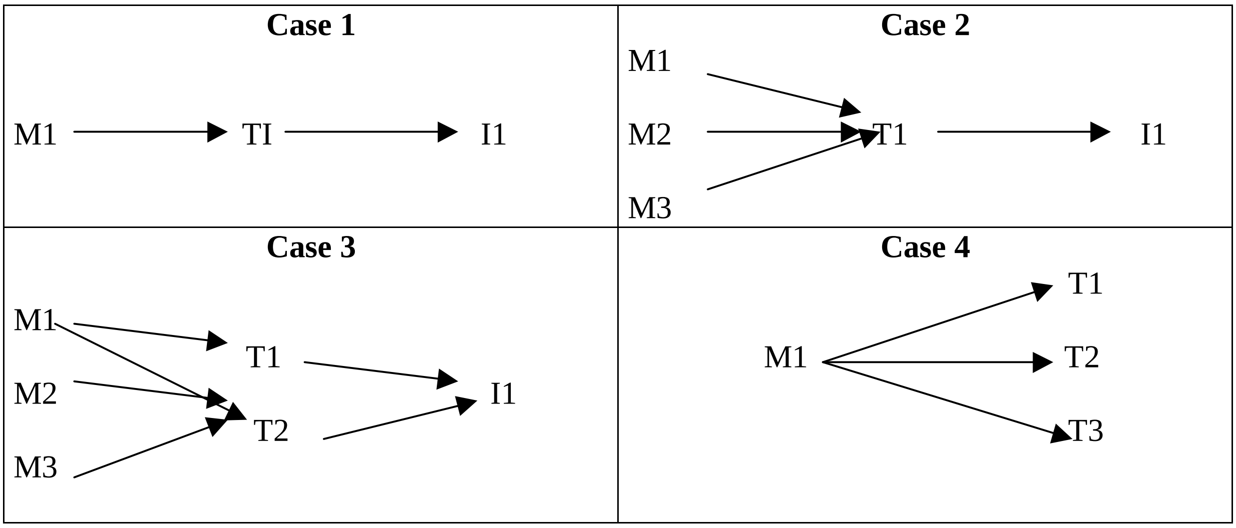
1) First of all, each indicator answers to a specific question, from a polical, economic or, technical view point. Depending on the exact question, one or several indicators can be considered;
2) Secondly, for a given question, one indicator may be proposed but cannot be calculated in some countries because of data gaps; in that case alternative indicators must be used that will be best approximations. For instance, 3 countries in the EU are not able to provide on a yearly basis accurate breakdown of the motor fuels by vehicle types;
3) Finally, energy efficiency has different meaning and frontiers (economic efficiency, technical efficiency). Depending on the perspective, some indicators may be more appropriate than others. For instance, specific consumptions are particularly suitable for assessing technical energy efficiency.

Nevertheless, several political commitments have encouraged the use and the publication of a selected number of "official" energy efficiency and CO2 indicators. In Europe, Eurostat and IEA has jointly initiated this year a process with member states to produce such indicators. Several criteria were used to operate this selection among which 1) the ability of answering to policy issues, 2) the sectoral representativeness, 3) the use of official data and simple methodology.

2. 3. Monitoring PAM's impact through indicators

In general, a policy is targeted to a particular "target" of final consumers or actors and each indicator aiming at monitoring these policies should be defined taking into account the caracteristics of this target. The better the target is homogeneous and well identified, the easier the monitoring will be, under the contraints of statistic availibility.

- The most simple case (but the less frequent), a unic measure acts on a unic target. In that case a direct relationship between the indicator and the monitoring of the measure can be found (**case 1**). The follow-up of the voluntary agreement can be classified in that case.
- Several complementary measures could be focused on the same impact (**case 2**): In that case, only the package of measures can be monitored through an indicator (case of the existing car fleet emissions).
- Due to statistical constraint an approximated indicator records several targets (**case 3**)
- The most difficult and complexe case occures when general measures (e.g. institutional, urban planning etc.) impacted on severall targets (**case 4**);
- In addition, some measures could also be designed to have an impact on activities itself (modal shift in transportation for example) and other sectoral policies (transport policy etc.) could also have impacts on CO2 trends.



M : Measure; T: Target; I: Indicator

Taking into account these observations, relevant quantitative information needed to assess policies impacts can be organised into 3 categories :

- **Energy efficiency indicators** which can be directly linked to energy efficiency policies.
- **CO_2 indicators** that will differ from the EEI by including the impact of the energy mix.
- **indicators of diffusion** of clean and efficient equipments and practices.

Indicators are not sufficient to assess by themselves the real impact of a specific measure, but reveal to what extent a set of measures implemented towards a source of GHG emission is efficient. The indicators identified below are suited to monitor the main driving forces responsible of emissions trajectory and related to the most common measures implemented. Some other indicators can be identified to capture the longer-term inflexions in emissions trajectories (change in urbanism, land planning…). In this presentation , only the two first categories will be presented. Consequently**, the indicators presented here do not capture the increase of the stock of vehicle. This effect can also be assessed and current and broadly known methodologies do exist.** However, the impact on CO2 changes of some some structural changes occuring in the composition of the car fleet (increase of powerfull car) will be partly assessed in the methodology presented here.

3. From the simplest to more advanced indicators

For each policy issue related to energy efficiency, **there is not one magical indicator** but rather a set of indicators. Nevertheless, in the decision-making process, effectiveness supports the idea of **selecting key indicators**. Due to statistical constraints and the need to have comprehensive indicators, we have privileged a presentation from the simplest to more advanced indicators. The simplest indicators are considered to be available in all OECD countries, but obviously there power of interpretation is rather limited. As far as the level of sophistication of the indicator is growing, the level of explanation becomes higher and provides a better approximation of energy efficiency efficiency. At least, they are able to take into account the national circumstances. The methodology and the illustrations are taken from the ongoing ADEME-EEC project « ODYSSEE » ((Bosseboeuf and ali (1999), (ADEME 2001)) gathering 15 E.U. countries.

3.1. Assessment of the overall package of measures for the existing cars fleet.

3.1.1. Yearly gasoline consumption or related CO2 emissions per gasoline Vehicles

The two following indicators need to be defined at a level of broad category each time the statistics do not enable the energy consumption of road transport to be broken down by type of vehicle and thus enable indicators to be calculated for cars only. This is the current situation for one third of European countries.

As in most countries, most of the consumption of motor gasoline for road transport is due to light vehicles; a straightforward indicator is the **unit consumption of gasoline or unit CO2 emissions per light vehicle**. It is obtained by dividing the total gasoline consumption for road transport by the total stock of gasoline vehicles. This category includes motorcycles, cars, and all commercial light vehicles (small vans, light trucks, minibuses, taxis) of which the definition usually varies from one country to another and overlaps with road freight vehicles.

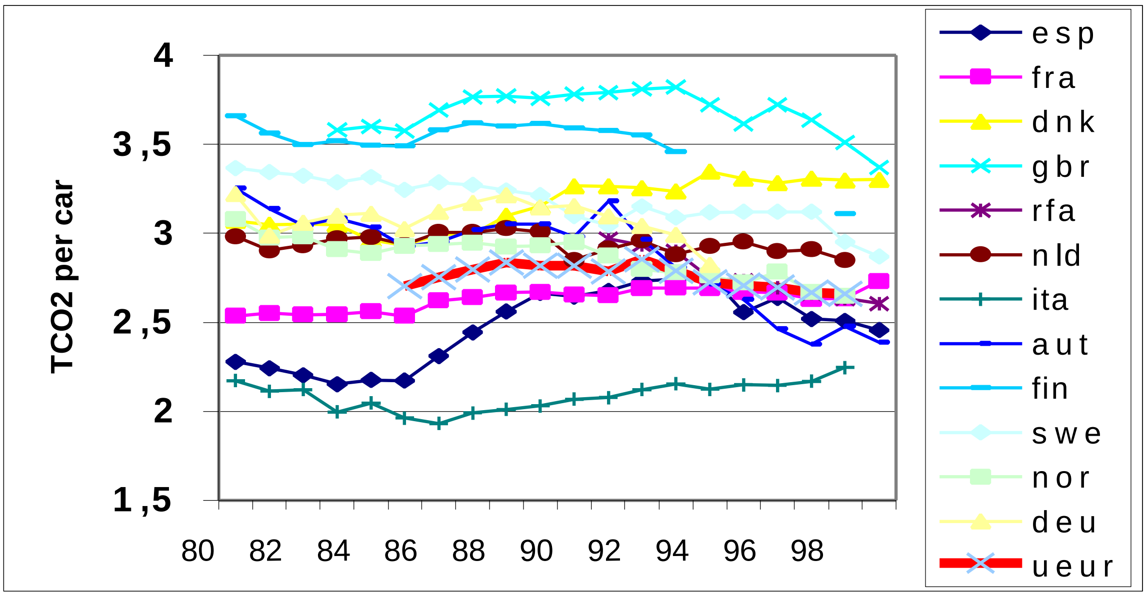
3.1.2. The unit consumption/emission per equivalent car

Using this unit consumption to interpret and compare the energy efficiency of light vehicles may be misleading due to the heterogeneity of the fleet of gasoline vehicles among countries and, within one country, over time. Indeed, the drawback of evaluating the average gasoline consumption per gasoline vehicle is that all types of vehicles are put on the same level. Motorcycles, cars and commercial light vehicles are added together: one motorcycle counts for one vehicle, as does one car. Therefore, if, the number of commercial light vehicles is increasing more rapidly than the number of cars, for instance, the unit consumption will increase, since on average a commercial light vehicle uses more fuel than a car (by a factor of between 1.5 and 2). Any change in the composition of the stock of vehicles will affect the unit consumption, even if the vehicles do not change from a technical point of view. For the reason mentioned above, the assessment is more relevant if carried out on a **unit consumption of gasoline per equivalent car**, light vehicles using gasoline being accounted for on the basis of the annual consumption of each type of vehicle in relation to that of cars. If an assessment of the energy efficiency of cars only is not possible, the unit consumption of gasoline per equivalent car represents a good alternative to assess the trends in energy efficiency for cars and commercial light vehicles together. Changes over time in this indicator will reflect the overall trends in energy efficiency combining the influence of both technical and behavioural factors.

3.1.3. An assessment of the overall package of measures : the yearly unit consumption or CO2 emissions per car

A new indicator can be calculated if missing data mentioned before are available. It represents an assessment of the performance of the overall fleet. For countries without data on distance travelled, only an average **unit consumption or emissions** of cars can be calculated (**fig. 1**). This unit consumption is the statistical division of the yearly motor fuel consumption of cars divided by the stock of cars. This unit consumption is the easiest indicator to calculate with the currently available statistics. It may be considered as an indicator of efficiency if a decrease in the use of cars is considered as an energy efficiency improvement: in other words, it indicates whether cars are used more or less efficiently, without indicating whether this is due to reduced mobility, improved technical efficiency or changes in driving behaviour. For these reasons, this indicators can only reflect the overall impact of the package of measures.

Figure 1 . Average CO2 emissions per car in selected European countries (1980-1999)



Source: odyssee data base

In Europe, we may observe a certain narrowing of unit emissions levls per car over the period. Partly differences can be explained by differences of distance traveled (mileage of italian car is 25% lower than in other european countries). Countries with a low level of emissions per car (Ita, Fr, Spa) gets an upwards trends. A contrario, some countries with higher level of emissions are more downward oriented (nld, gbr). Nevertheless exeption are always existing due to national circunstancies (dnk).

3.1.4. An assessment of the Overall energy efficiency of cars (l/100 km, gCO2/km)

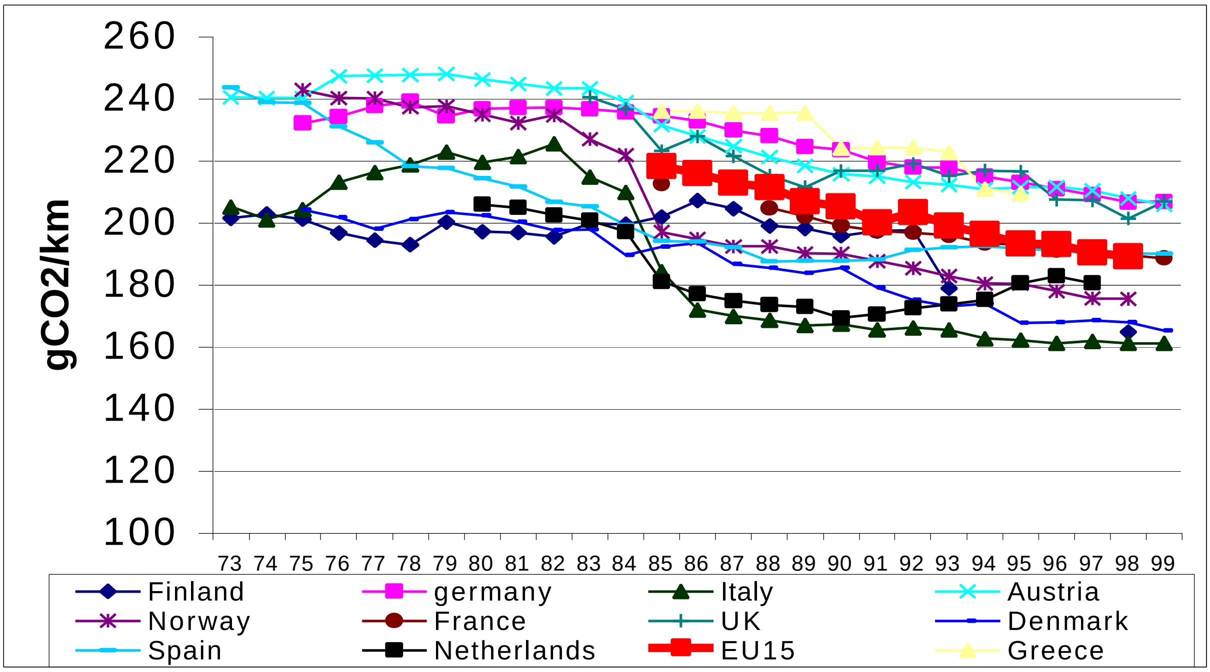
The interpretation of the previous indicator can be improved in cleaning out the influence of the distance traveled changes. In that sens, this new indicator can be interpreted as a better proxy of car performances improvment. However, more and more, some energy efficiency policies claims to participate to mileage reduction (transport organisation measure, taxation on fuel use) or to contribute to indirectly increase the mileage through the "rebound effect". The overall efficiency represents the amount of energy required to move a vehicle: it depends, in addition to the technical efficiency, on the driver's behaviour, the speed, the pattern of use of the vehicle (short distances, number of stops, etc), the load, etc.

At the macro level, i.e. for all vehicles in a country, another factor affects the overall efficiency. This is the relative share between different types of vehicle. An increasing share of more powerful cars or larger cars in the total number of cars will, all things being equal, decrease the overall efficiency, and vice versa.

Therefore, at the macro level, the overall efficiency of cars depends on their technical efficiency, on behavioural variables in the use of vehicles, and on consumers' preference for certain types of car, in terms of size, engine power, comfort, equipment (e.g. air conditioning).

The impact of these driving forces of CO2 trends can be captured in **calculating an average specific consumption or CO2 emissions for cars (gco2/km).** it can be calculated from the total consumption of cars, the stock of cars and the average distance travelled by year by car. Such specific consumption can only be calculated if data on distance travelled by car are available. A distinction can be made, when data are available, between gasoline and diesel cars. **Figure 2** shows the data available from the ODYSSEE database on the average specific CO2 emissions of cars. Specific consumption can also be obtained from surveys or panels.

Figure 2: Average specific CO2 emissions of the car fleet in selected European countries



Source : odysee data base

Cleaned from mileage differences, the dominant trend is downwards for the E.U.and a certain convergence among countries in CO2 performances improvment can be seen without any break even after the "counter-oil shock" in 1985/86, and at a fairly similar rate in most countries. Germany stands as an exception with a very low decreasing rate, and Austria as another exception with a decrease that is significantly higher than in other countries; the UK also experiences a specific trend after 1989 (more or less stabilising). The range of related specific consumption is roughly from 7 to 9 l/100 km in 1998/1999.

3.2. Assessment of the package of PAM's towards new vehicles.

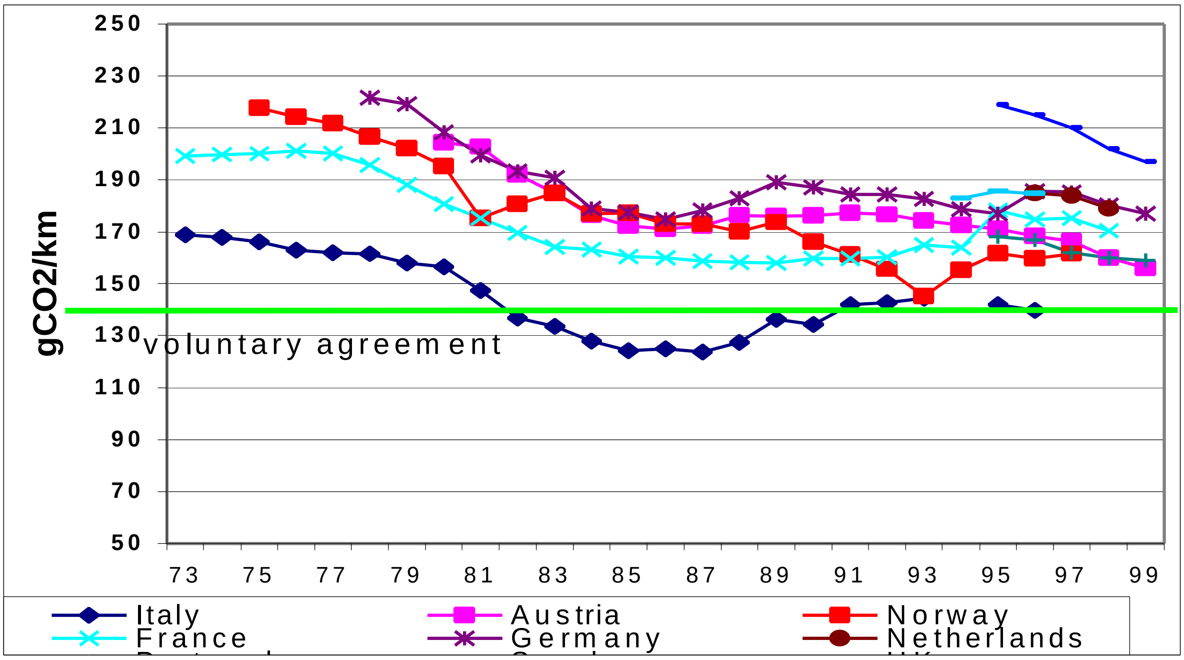
3.2.1. Technical Versus Overall Energy Efficiency of cars.

Are cars more efficient now than before the first or second oil crises? Are cars getting more efficient or cleaner every year? The answer is not simple, as it depends whether we refer to technical or overall energy efficiency. During and after the two oil crises, manufacturers made .special R&D efforts, usually with support from energy efficiency agencies, to improve the technical efficiency of road vehicles.

3.2.1. how to monitor the impact of R&D policies and the voluntary agreement? : tested values of new cars follow-up:

Technical efficiency can be monitored with a specific consumption or emissions measured in standard conditions. For new cars sold each year, this technical efficiency is characterised through a « conventional » or "**test specific consumption or emissions"** as measured by a fuel consumption test (**fig.3**). These test values are provided each year by energy administrations or associations of car manufacturers to monitor energy efficiency trends with new cars. They are given for each brand of car and calculated as a sales weighted average. For new cars, such data are currently available in most countries.

Figure 3: Tested specific consumption of new cars (gCO2/km)



Source: Odyssee data base

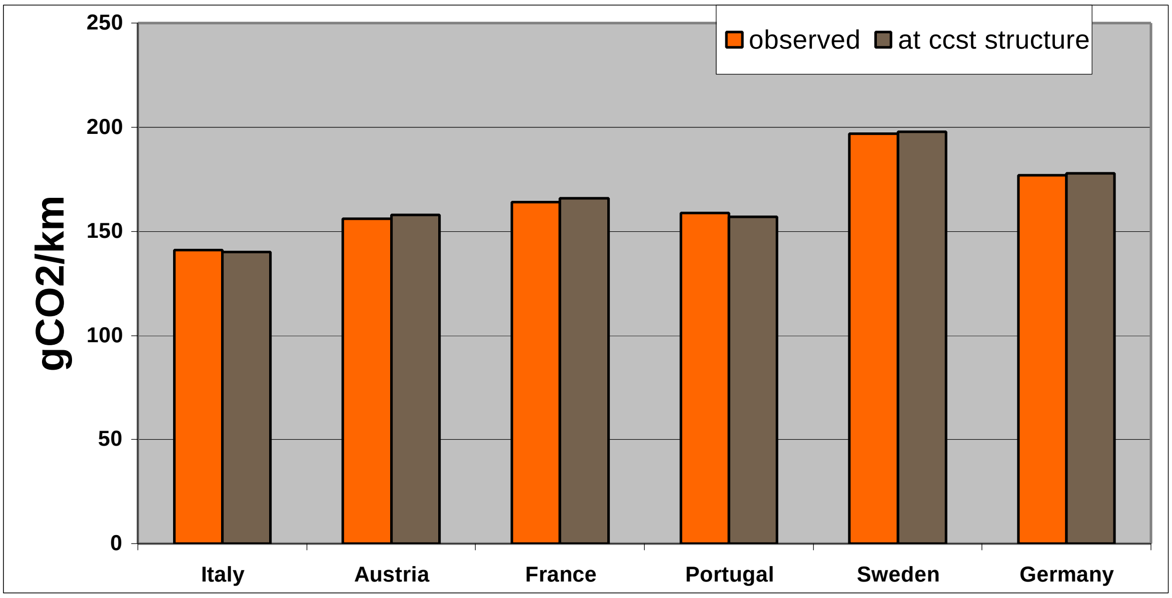
In all countries, this test specific emission decreased significantly from 1980 until the mid-eighties and a relative convergence can be observed**.** Some countries are already closed to the limit fixed by the voluntary agreement (140gCO2/km). In recent years, this trend has slowed down or even reversed. Can we conclude that there are no more technical improvements? Yes, if the structure of the stock of cars remains fairly stable. No, if it is changing.

3.2.2. How to sort out some structural differences on tested values?

The previous indicator, however, not only reflects changes in energy efficiency from a technical point of view, but also changes in the structure of new car registrations by size category or fuel type (gasoline/diesel). For instance a shift towards smaller cars (or diesel cars), all things being equal, decreases the test specific consumption. To eliminate this phenomenon, another indicator can be calculated: **a test specific consumption of new cars at constant structure**.

A distinction can be made according to motor fuel type, as in some countries (e.g. France) an increasing number of diesel cars are being sold. For a given vehicle size, diesel cars are more efficient than gasoline cars, by a factor of 5 to 10% in energy units (toe or Joule), and their .spread may explain a reduction in the average test consumption. To assess the influence of t.he penetration of diesel cars, a **specific consumption of new cars at constant structure by fuel type** (**fig.4**) can be calculated in the same way.

Figure 4 : Impact on CO2 performances in 1999 of inter-fuel substitution of new cars (cst structure 1995)



Source : Odyssee data base

In the recent period, no major impacts of interfuel-substitution of new registration can be observed in Europe. It is due to the fact that there is no a big difference in the CO2 performances between diesel and gasoline fueled-vehicles. This indicator will be more valuable when hybrid or electric vehicles will be put on the market and are a relevance on a longer term basis.

For a cross-country comparison of the performances of new cars, a direct comparison of average test specific consumption may be misleading as the structure of new registrations varies quite a lot from one country to another. For that reason, comparisons should be based on an **adjusted specific consumption of new cars**, calculated by taking into account the actual specific consumption by category of car, with a reference sales structure (e.g. the EU average).

To calculate specific consumption at constant structure or adjusted specific consumption, it is necessary to have comparable data on car sales by category and test specific consumption by category, corresponding to the same category. This is a particularly strong limitation in calculating the adjusted specific consumption.

Can we now consider that the test specific consumption at constant structure fully reflects trends in energy efficiency from a technical point of view? Actually, this ratio also includes changes in car characteristics; namely a change in the average weight of cars, as analysed by IEA (1997). This influence can be quantified by calculating a ratio **of fuel consumption of cars divided by weight (in 1/100 km/kg)**.

3.2.3. How to measure technical efficiency trends for the entire stock of cars?

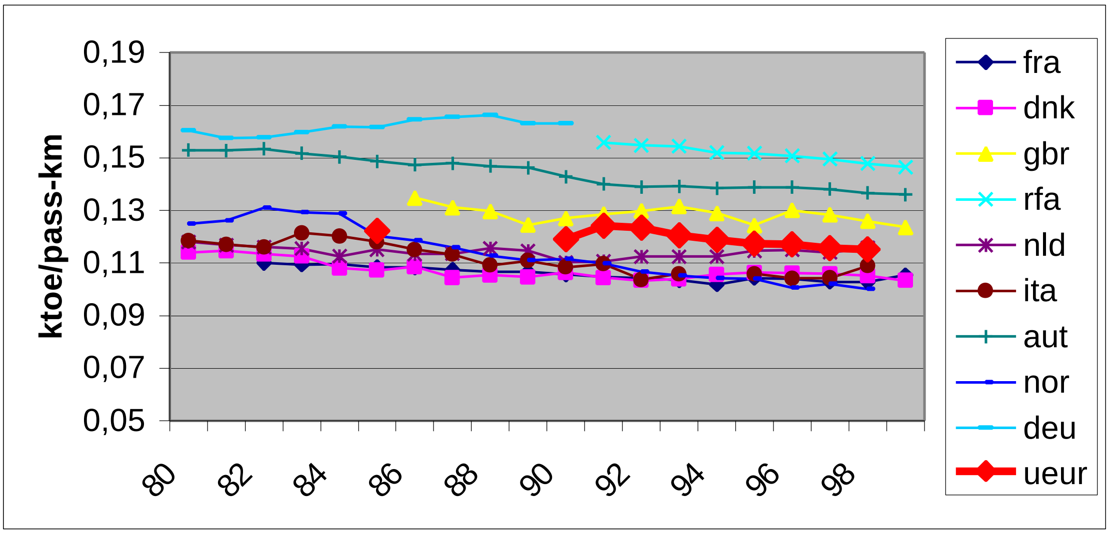
Can we assess trends in technical efficiency for all cars, i.e. as an average for the stock of cars? In ODYSSEE, an indicator has been introduced to provide some answers to that question: the **theoretical specific consumption** of the car fleet. It is calculated using data on the car population, according to vintages, and on the specific consumption of new cars. This indicator is the most appropriate for tracking improvements in the energy efficiency of cars, in relation to technological improvements, despite the fact that the re-calculation may bring some bias. The difference in changes in specific consumption and theoretical specific consumption shows the impact of non-technical factors on energy efficiency: consumer behaviour for the choice of car model, driving behaviour, traffic conditions, etc.

3.3. The evaluation of transport organisation measures

3.3.1. The efficiency of the transport services : (goe or gCO2/ pass-km)

The specific consumption does not, however, give all information on the energy efficiency of the overall transport services. There are more and more policies which aim to improve the load ratio of cars through transport organisation measures. To assess whether car mobility is becoming more energy-efficient, another indicator can be used, that is the **unit consumption or emission per pass-km (fig 5)**. Nevertheless, concretely, statistical lacks limit the use of these indicators because most of times, the evolution of pkm is taken parallel to the vkm.

Figure 5 : Unit CO2 emissions of car services in selected european countries (kCo2/pkm)



source : odysse data base

3.3.2. Assessment of policies changing the modal split :

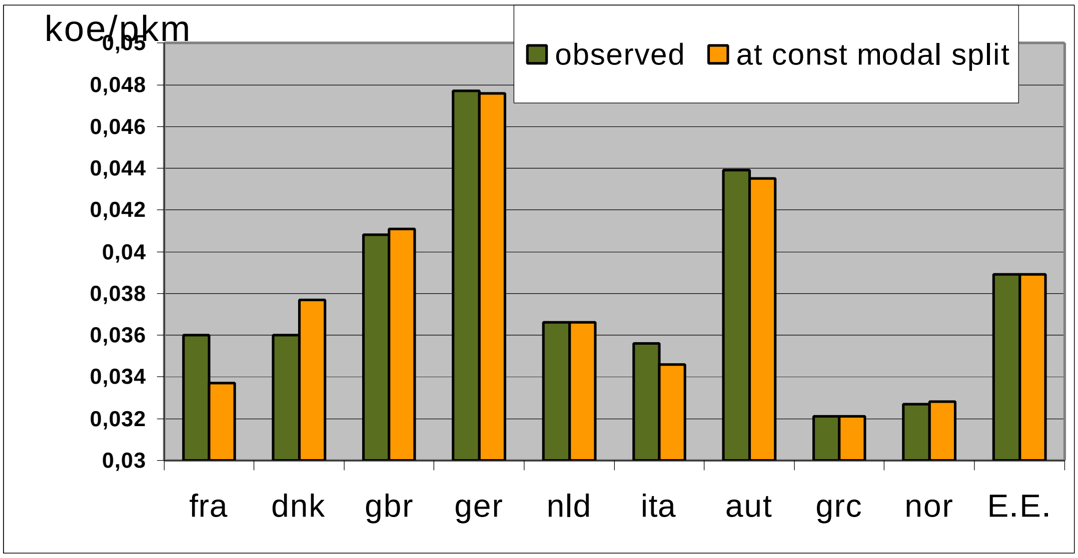
Looking at each mode separately is not enough to get a correct diagnosis of CO2 emisions trends, as over time substitutions between modes take place. In particular a key question is what is the impact of substituting cars for public transport for passengers. Here, the question is no longer a matter of technical energy efficiency but of the overall energy efficiency of transport, as these substitutions imply an increase in the amount of energy used per unit of traffic. In all European countries, there is a general trend towards an increasing share of car mobility in passenger transport. This modification in the modal distribution tend to decrease the overall efficiency of transport, as more energy is required per unit of traffic. At the same time, policies have been implemented in some countries (transport organisation policies) or are being considered in others to reverse this trend by promoting the use of public transport in cities for instance. Two questions need to be addressed when considering energy efficiency or CO2 emissions in transport:

- how much of the increase in the energy consumption of the transport sector can be attributed to these modal substitutions?
- how much energy is being saved in countries that have implemented policies and have started to reverse these trends?

The problem is how to measure such influences, which will be referred to as a "modal distribution effect" (structural effect). A "homogeneous growth effect" is first calculated by aggregating a fictitious energy consumption for each mode, obtained by assuming the same rate of growth of traffic as for the total traffic, in passenger-km for passengers, in ton-km for goods. The "modal distribution effect" is then obtained by the difference between the quantity effect reflecting the influence of changes in the number of vehicles for road transport, or in the traffic for the other modes, and the homogeneous growth effect (**fig. 6.**).

The substitution trends we have discussed earlier result in a positive modal substitution effect, whereas the policies implemented to promote public transport, if they are successful, should bring negative values for this effect, which could be considered as energy savings.

Figure 6: Impact of modal shift on energy efficiency (1995 cst modal struture)



Source : Odyssee data base

Conclusion

Complementary to micro evaluation of programmes or measures, it is possible in certain cases, to interpret CO2 trends with quantitative information in relation to implemented policies. Based on observed situation, an expost evaluation using detailed macro indicators allows to properly monitor measures and, more often, the impact of a package of measures on CO2 trends. It answers to the necessary needs to go far beyond the sole inventory to understand how policies shapes CO2 trends. This method increases the transparency the assessment of the measures taken under the condition that the methodology is simple and corresponds to a consensus.

In this paper, a selection of key indicators related to emissions performances have been defined, illustrted and interpreted for European countries. **Table 1** summarizes the major finding showing the needed indicators for assessing a package of measures applied to a particular target.

Table 1: example of relation ship emission performances, emitors target and PAM's.

Measures towards new vehicles	Indicators
- Support to R&D - Technology procurement - Labelling - Voluntary agreement - Taxation (purshasing, ownership, fuel use) Subsidies to alternatives	L/100km GCO2/km
Measures towards the existing fleet	**Indicators**
Taxation (ownership, use etc) Technical control Scrappage of old vehicles Transport organisation measures	TCO2 per car GCO2 per km GCO2 per pkm

Many more detailed indicators can be considered to provide a better link between individual measures and CO_2, but increasing the number of indicators is an obstacle to a synthetic and common appropriation by policy makers among the various countries. It is possible with more advanced indicators to clean these indicators to structural differences among countries in order to take into account national circumstancies.

This case study presented here illustrates, under the condition of homogeneity of target to be evaluated, that a reasonable interpretation allows usto verify if policies have impacted on trends. Through a collaborative process, the experience of 15 European countries shows that this methodology is yet operational. The officialisation of such kind of indicators engaged by Eurostat and IAE participates to this process of information transparency.
Such an approach has been tested in some non annex 1 countries with a relative amount of sucess but of course merit more experiences.
Current achievement of the ODYSSEE project certainly permits to support the idea for a scope of quantitative reporting as an input for the exchange of information on Policies and Measures. The issue is to find the best compromise between on the one hand, a broader use of indicators which requires transparency in the methodology including data collection, definition of indicators etc.. and on the other hand, their use will increase in relation to their ability to correctly interpret the policies impact. Both these two objectives mutually reinforced.
Obviously it should not prevent to annex more in depth evaluations of specific measures and qualitative assessments on the interpretation of each indicator related to different measures. Other indicators could be identified to assess longer term emissions trajectories such as public investments in collective transports, sustainable urban planning or which could capture the impact of acticity changes (more car).

Bibliography

ADEME-APERC, Moisan F., Yokobori K, Bosseboeuf D. (2001*): "Energy efficiency policies and indicators"*, WEC rapport, London
Bosseboeuf D., Château B., Lapillonne B. (2000): *"Monitoring Energy effiency and CO2 abatement policies: What can be learnt from indicators?»* UNFCCC workshop best practices in PAM's, Copenhagen
Bosseboeuf D., Château B., Eichhammer W.; Lapillonne B. (2000): *« Cross country comparison on energy efficiency indicators phase 6 : the ODYSSEE data base* », final report phase 5, 5 volumes, ADEME, Paris
Bosseboeuf D, Lapillonne B., Eichhammer W. Landvert M. (1999): *« Energy efficiency indicators: the European experience* ». ADEME collection, Paris,
Bosseboeuf D., Richard C. (1997) : « *The need to link energy efficiency indicators to related policies. A practical experience based on 20 years of facts and trends in France* », in Energy policy Vole 25 N° 7-9 July 1997, p p 813-824.
EUROSTAT (2000): **"***The priority list of energy efficiency indicators***",** Luxemburg
Goodwin (1988) **"***Evidence on car and public transport elasticities*", TSU paper 427, Oxford University;
IEA-Fulton R. (2000*): "Fuel economy improvement, policies and measures to save oil and reduce CO2 emissions*", COP6, den Hagen
IEA-Schipper L. (1997) **: «** *The link between energy and human activity* », Paris, 120p.
ISIS-CEE (2000) **:** *« Cantique project :evaluation of non technical measures in transport in Europe* », Roma
MIES (2000) : « *Programme national de lutte contre l'effet de serre* », Paris
Orfeuil J.P. (2001): *« Tax regimes and CO2 emissions* », report for ADEME-WEC, Paris university-ŒIL, Paris»