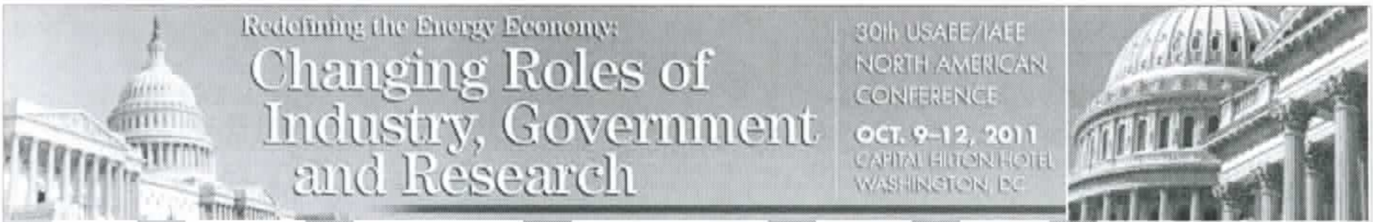

CONFERENCE OVERVIEW

As we recover from the global recession and the disastrous Macondo deep water oil spill, concerns are once again mounting about energy supply, and especially the environmental and carbon implications of continued heavy reliance upon fossil fuels. Will increasing energy demands once again drive up energy prices? How should governments and firms react in terms of developing or facilitating new supplies and efficiencies? How should resources and alternative energy sources be developed, regulated, financed, traded? The clash of interests resounds starkly here in Washington, at the U.S. government's door, amid new legislation, evolving energy technologies, and continuing price uncertainties. Energy analysts, economists, financiers, developers, regulators, and students-each must revisit some basic assumptions about their roles, methodologies, research and planning focus, and the information they are using.

This conference will bring together in Washington key players in the North American energy sector to address these questions and many others in plenary and concurrent sessions. Those interested in organizing sessions should propose a topic and possible speakers to Wumi Iledare, Concurrent Session Chair (wumi@lsu.edu). This conference will also provide networking opportunities through workshops, public outreach and student recruitment.

WHO SHOULD ATTEND?

- Energy Company Executives and Managers
- Energy Policy Analysts
- Governmental Employees in Energy Resource Planning
- Academics Specializing in Energy Policy and Analysis
- Electricity Pricing and Market Analysts
- Energy Consultants
- Energy Company Planners
- Economic Energy Risk and Derivatives Specialists
- Oil and Natural Gas Executives
- Energy Rate Executives
- Electric and Utility Supervisors
- Energy Environmental Analysts
- Geologists and Engineers
- Environmentalists
- Energy Journalists

NETWORKING DINNERS

NEW TO USAEE? DON'T EAT ALONE! After the Opening Reception, USAEE Council members and presidential advisors will lead several small groups of newcomers to networking dinners at various restaurants within walking distance of the conference hotel. This will be a great opportunity to meet a number of conference attendees at the outset of the conference. Please note that all attendees will be responsible for paying for their own dinner.

Sign-up will be first-come, first-served either by e-mail prior to the conference or at the conference during the Opening Reception.

Scenes from the Conference →

FOR MORE INFORMATION :

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USAEE/IAEE Headquarters
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A LEAST-COST APPROACH TO REDUCE CO_2-EMISSIONS IN PASSENGER CAR TRANSPORT: THIS TIME ECONOMICS WILL KILL THE ELECTRIC CAR

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Abstract

Reducing CO_2 emissions (note that CO_2 refers to CO_2-equivalents) in road passenger car transport is a major objective of many governments world-wide. To meet this goal various types of policy strategies – fuel or registration taxes, promotion of biofuels, technical efficiency improvements of conventional cars as well as introduction of hybrid and battery electric vehicles (BEV) – are considered.

A very important issue in this context is to achieve specific objectives – e.g. (-20%) to 2020 in the EU – with a minimum of costs. All of the policies mentioned above are associated with corresponding costs for the customers and for society as a whole.

The core objective of this paper is to analyse the costs – and the corresponding CO_2 reduction potential – of the policies documented above for the EU-15 countries. Furthermore, we aim for identifying the cost-minimal portfolio of measures to meet the EU's 2020 target. This work is based on the outcomes of the EU-funded project ALTER-MOTIVE, see Ajanovic et al., 2011a and www.alter-motive.org.

Introduction

The major challenges for EU climate and energy policy are to implement effective policies and measures to mitigate global warming, to improve air quality and to reduce energy consumption.

The 20-20-20 targets provide concrete goals which state that

- at least 20% renewable fuels should be used in the energy sector;
- at least 20% CO_2 emission reduction (compared to the 1990 level);
- at least 20% energy efficiency improvements by 2020;
- at least 10% renewable fuels for transport (attached to the 20-20-20-target (EC, 2008; EC, 2009)).

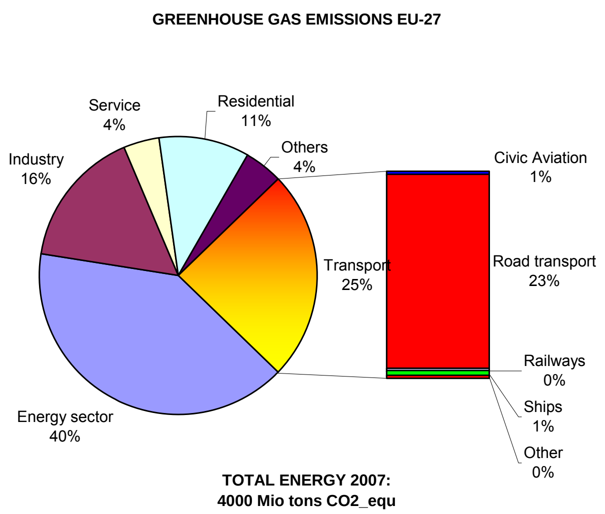

Figure 1. Share of greenhouse gas emissions in EU-27 by sector in 2007 (only domestic transport considered) (EU, 2010)

Since road transport contributes with about 23% to the EU's total greenhouse gas (GHG) emissions a large part of these EU-targets must be directed to this sector, see Figure 1. Passenger cars alone contribute to 70% of road transport GHG emissions in the EU (EU, 2011).

So a wide range of EU policies to lower emissions from passenger car transport is already in place, such as emissions targets for new cars, targets to reduce the greenhouse gas intensity of fuels, labelling requirements etc.

It is obvious that urgent actions are required to meet EU energy and environmental targets.

The core objective of this paper is to analyse the costs – and the corresponding CO_2 reduction potential – of the policies documented above for the EU-15 countries. Furthermore, we aim for identifying the cost-minimal portfolio of measures to meet the EU's 2020 target. This work is based on the outcomes of the EU-funded project ALTER-MOTIVE, see Ajanovic et al., 2011a and www.alter-motive.org.

Methods

To get a reliable appraisal of the effect of different policy measures on the CO_2 reduction it is very important to recognise what are the major factors that finally influence CO_2 emissions. Figure 2 shows how CO_2 emissions in passenger car transport come about and how they can be reduced in principle.

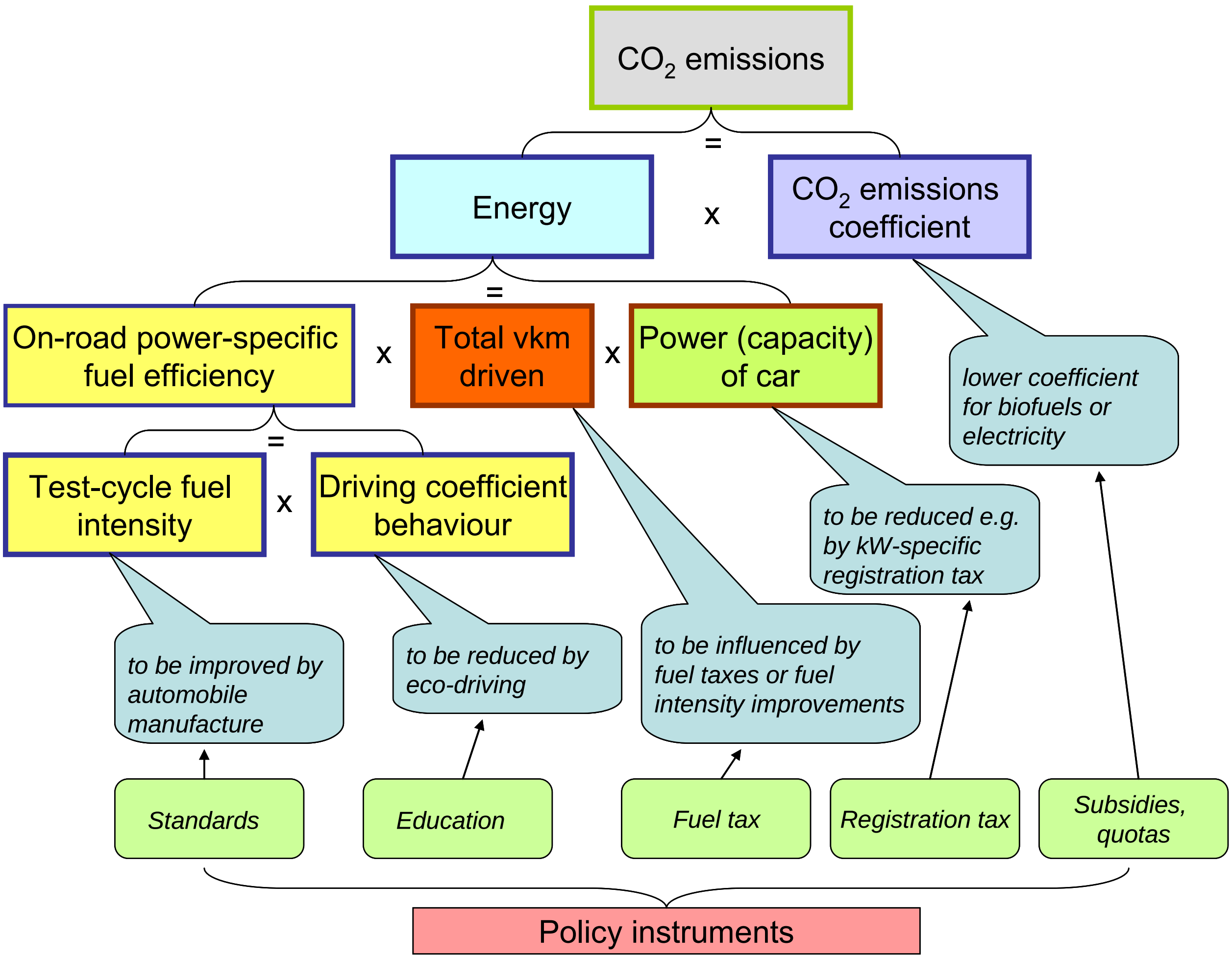

Figure 2. Impact factors on CO_2 emissions in the car passenger transport sector (Source: adapted from JAMA, 2008)

As discussed in Ajanovic at al., 2011b, CO_2 emissions from passenger car transport depend in principle on energy used for transport and the average specific CO_2 emissions coefficient of different fuels used. The coefficient f_{CO2} can be improved, e.g. better quality of fossil fuels, better ecological performance of biofuels, more electricity from renewable energy sources.

Total energy consumption can be reduced with better on-road fuel efficiency (lower energy consumption per km driven and per kW), lower travel activity (less vkm driven) and smaller cars (less kW).

On-road power specific fuel efficiency is influenced by (theoretical) test-cycle fuel efficiency and the individual driving behaviour.

Note that different policies can have multiple and even contradicting impacts. Total vkm driven can be reduced by fuel taxes or increased by fuel intensity improvements due to the rebound.

To find out how CO_2 emissions can be reduced we first identify what influences total CO_2 emissions EM_{CO2}. They come about as follows:

$$EM_{CO_2} = vkm \cdot FI \cdot f_{CO_2} \tag{1}$$

With

vkm…Vehicle km driven,

FI …. .Fuel intensity (litre per 100 km)

f_{CO2} ….Specific CO_2 emissions per litre fuel.

$$vkm = f(P_S, Y) \tag{2}$$

With

P_S….Service price

Y…..Income

$$P_S = P_F FI \tag{3}$$

With

P_F….Fuel price

So we can reduce CO_2 emissions by influencing either:

- vkm (by increasing the price by taxes) or
- FI (by introducing various measures for technical efficiency improvement) or
- f_{CO2} (by using fuels with less carbon, e.g. biofuels, or electricity).

The method of approach is finally based on calculation of total costs for society and resulting CO_2 reductions:

- For taxes these costs are the welfare losses for society;
- For the technologies we consider the additional investment costs of the technology and the energy cost reduction respectively the increased producer surplus if the technology is produced in the region;

- For alternative fuels we have to consider the additional production costs minus the increased producer surplus if the technology is produced in the region.

For the last two categories it is furthermore important to consider the technological learning effect.

Results

Policy measures implemented in transport sector could be put in three main categories:

- **Switch** from fossil fuels to alternative fuels, in the first line to biofuels;
- **Improve** efficiency of cars including switch to alternative and more efficient powertrains;
- **Reduce** energy consumption with taxes and standards.

Switch

Currently most important alternative fuels are biodiesel (BD-1) and bioethanol (BE-1). Although low, share of biofuels in total transport fuels demand is increasing all over the world mostly due to biofuels targets and different government incentive programs. Reason for this policy is the fact that biofuels have potential to contribute to replacing fossil fuels and reduce CO_2 emissions in transport sector. However, over the past decade, biofuels have been more expensive than fossil fuels and reduction of CO_2 emissions was moderate. Since the preferred feedstocks for current biofuels are corn, wheat, sugarcane, rapeseed, soybean and sunflowers, the very important issue is relation between biofuels production and increasing food prices, see also Ajanovic, 2010.

However, the largest expectation in a future is from the biodiesel and bioethanol of 2[nd] generation (BD-2, BE-2).

Figure 3 shows an aggregated picture of the development of fossil fuels versus biofuels production costs and WTW CO_2 emissions [g $CO_{2\text{-eq}}$/MJ] from 2010 to 2020. We can see that only the costs of BF-2 can be expected to decrease moderate, while BF-1 will become slightly more expensive. Yet, the potential for ecological improvements is highest for BF-1.

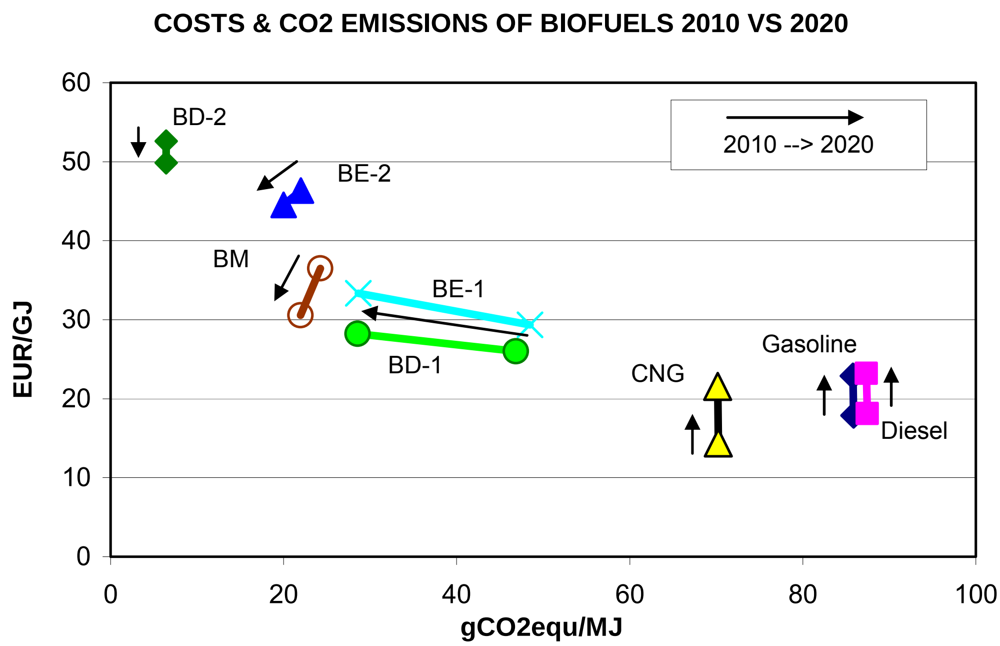

Figure 3. Fossil fuels vs. Biofuels production costs (exclusive taxes) and WTW CO_2 emissions, 2010 and 2020 (Source: Toro et al, 2010; Ajanovic et al, 2011b)

With respect to the ecological performance of BF-1 the best option corresponds to biogas with lowest specific emissions. BD-2 performs better than BE-2 in terms of CO_2 emissions per Megajoule (MJ). The values provided here for 2[nd] generation biofuels are still disputable as they are based on R&D or demonstration figures, but still no scalable experience has been obtained. BD-2 has the prospect to offer lower emissions in this case due to the co-generation assumption covering high energy inputs; however, the capital requirements observed are very high. Along the whole chain biodiesel from rapeseed and bioethanol from wheat are exhibiting the higher $CO_{2\text{-eq.}}$ emissions per delivered MJ of fuel due mostly by cultivation and fertilizers use as well as the use of fossil based inputs.

Improve

To reduce energy consumption and at the same time CO_2 emissions, it is important to improve efficiency of conventional diesel and gasoline vehicles as well as to increase the number of alternative and more efficient powertrain systems (such as battery electric vehicles (BEV) and fuel cell (FCV) vehicles) in the total vehicle stock.

According to Toro et al (2010) major improvements of conventional cars to be considered are:

- The internal combustion engines exhibit important technical improvements with the potential to increase efficiency and reduce emissions with moderate extra costs. Several of these technologies are highlighted and among others include the application of engine test bed, optimised fuel injection and electronic systems, modern valve controlling and innovative gear drives (e.g. duplex clutch, continuous automatic gearbox, hydraulic impulse store);
- Further improvements include chassis suspension and brake technology, reduction of rolling resistance of tyres (e. g. innovative materials or optimised tyre profiles), improved aerodynamics, light weight constructions (e. g. substitution of steel by plastics and carbon fibres, substitution of conventional headlights by light-emitting diodes), material from renewable raw materials and optimisation of the power train;
- Integration and use of advanced accessories such as tire pressure monitoring system (TPMS), gear shift indicators (GSI), navigation systems, radio based traffic monitoring and update systems are few other measures that will add to vehicle / system efficiency;
- Additional modification on internal combustion engine (ICE) include the adaptation of motors to run on low or high blend biodiesel or bioethanol which offer a potential to reduce emissions while making few changes in the technology.

Aside from continues improvements of conventional vehicles in the future switch to new technologies like BEV or FCV will play an important role in the reduction of the CO_2 emissions.

However, it is important to note that BEV and FCV are still immature technologies but with considerable technical improvement potentials- see Toro et al (2010) for further details – which include:

- Major R&D and demonstration activities relate to further development of battery technologies and technology improvements indicate a wide range of weight and costs reduction potentials until 2020 probably explained by the different scaling factors for battery and cell sizes;
- Technical improvements for fuel cells include power density and platinum loading which are necessary to go on commercial scale. The cost evaluation of fuel cells for automotive power trains suggests that in future significantly lower costs of fuel cell systems can be expected due to scale production and technology learning. Until 2020, the contribution from hydrogen as a transport fuel remains limited and several technical improvements remain at research, development and demonstration with promising potentials after 2020. Major challenges include reduction of energy and resource losses in over-all conversion chains, to make the production process cheaper as well as to enhance the reliability and life-time of fuel cells and to bring the learning curve of costs.

Figure 4 provides a comparison of specific CO_2 emissions and costs of conventional and hybrid gasoline and diesel vehicles with pure BEV based on different electricity generation mixes and FCV with H_2 from renewable energy source (RES) or natural gas.

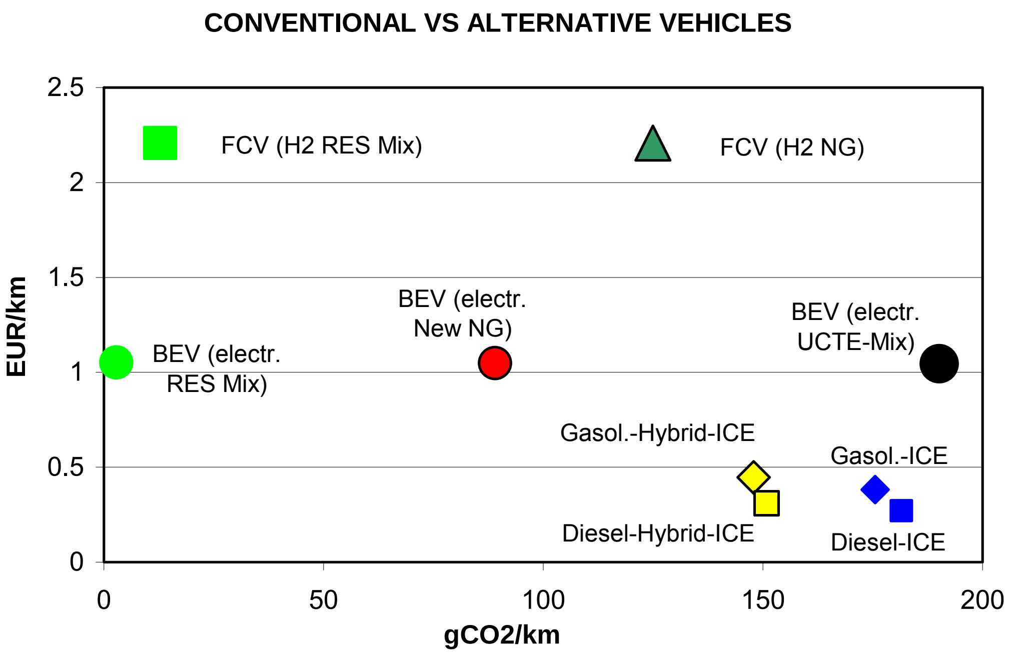

Figure 4. Comparison of specific CO_2 emissions and driving costs of conventional and hybrid gasoline and diesel vehicles with pure BEV based on different electricity generation mixes and FCV with hydrogen from NG vs RES (Source: Toro et al, 2010)
(H2: Hydrogen, ICE: Internal Combustion Engine, FCV: Fuel Cell vehicle, BEV: Battery Electric Vehicle, NG: Natural gas)

The major perceptions of Figure 4 are: (i) Hybrid ICEs are an alternative with slightly higher costs but clearly better performance than conventional vehicles; (ii) BEV as well as FCV are only preferable to conventional cars if they are fully based on RES.

Reduce

To put alternative fuels and alternative automotive technologies on the market efficient and supporting policy measures are very important. They need to be well-timed according to the current technological status. Therefore, the technology status should be carefully analysed before the introduction of measures. As sometimes the technological development and learning curve move ahead fast, close technology monitoring and flexible policies are suited best. The biggest pitfall from a policy maker perspective can be tax exemptions without budget restrictions which become (very) expensive when the market shares of the technology or fuel in case grows more rapidly than expected.

Generic policies like CO_2 based fuel taxes are effective to achieve overarching goal of emission reductions, however the market will decide upon the cheapest technological option. This option does not necessarily entail the biggest carbon abatement potential in the long-term.

Fiscal policies currently applied for conventional vehicles need to be distinguished between one time measures such as vehicle purchase tax (also called registration tax) and annually levied road taxes. Vehicle purchase taxes have proven to be influential on the magnitude of car sales and the choice by the consumer for a certain model. Annual taxation schemes based on vehicle's CO_2 emissions (and the car footprint, not weight) are seen as a more direct way of influencing consumer decisions. In this case, a limit needs to be defined for maximum allowed emissions level together with penalties that are imposed if the limit is exceeded. Favourable company car depreciation schemes do currently weaken the impact of purchase taxation schemes, therefore more personalized schemes targeting the behaviour of the individual motorist (e.g. incentivising reduction of kilometres driven per car through fuel taxation) are seen as a next step.

Biofuels 1st gen.: Main barrier for the 1st generation of biofuels is cost and debate on environmental impact. The scope for cost reductions in the 1st generation of biofuels is limited, so policy measures to increase the market share of biofuels are likely to be expensive. The basic choice is which stakeholder is going to bear these costs. When tax exemptions are applied, the costs are borne by the national government and eventually all tax payers. When an obligation is applied, the costs are born by the fuel providers and fuel consumers.

Biofuels 2nd gen.: Their costs are currently too high to allow the development of an early market. Policy should for now focus on support for R&D and demonstration projects. This is currently the case at EU level; R&D results should lead to demonstration and early commercial stages. Despite of the fact that technology learning is expected to contribute to reduce the costs, simulations from Toro et al., 2011 indicates that this effect might be very limited also for routes for high energy scenarios.

CNG requires a significant fuel price discount over conventional fuels and a shared vision by the relevant market actors that a viable market for CNG can be developed. Since CNG is currently more popular in new vehicles than in conversions and because CNG infrastructure is relatively expensive (compared to LPG), measures aimed at direct support for vehicles and infrastructure development may be considered to accelerate early market development.

Hybrid electric vehicles (HEV): Main barrier are high vehicle costs in comparison to conventional vehicles. Support measures that bring the costs of vehicles down are successful, especially measures that make the private use of company cars (lease) more attractive.

Hydrogen: Main barriers are the initial cost of fuel cell vehicles (consumers) and high upfront investments in infrastructure (industry). The costs of vehicles can be brought down by (i) R&D and learning-by-doing in demonstration projects and (ii) reaping scale advantages of mass production. This requires support for R&D and demonstration projects on the one hand and direct support to bring down the costs of the first batches of vehicles on the other hand. Infrastructure investments can be triggered by implementing measures that offer a viable long-term perspective to fuel providers, but also by more direct measures such as investment subsidies and accelerated depreciation. Locally initiated hydrogen implementation projects (bottom-up) provide first experiences with technology and grow out into corridors (links) to other hydrogen application centres. With limited availability of hydrogen passenger cars, public transport buses or niche applications can be a starting point.

BEV: Main barriers are high initial vehicle cost (in particular for batteries) and limited driving ranges. Support should aim to lower cost through battery R&D and demonstration projects (learning by doing and volume effects). More experiences are needed regarding what coverage of charging infrastructure is really required (and will be utilized) by end-users. Consumer incentives are suitable to provide a financial relief to reduce initial high vehicle cost, either in form of tax incentives or as a direct subsidy.

Although providing incentives and other amenities for particular fuels & technologies is often regarded as ‘picking winners’ from which policy makers should refrain, the risks from choosing certain innovations are outweighed by the risk of not attaining climate policy targets at all.

In order to achieve the GHG emission reduction target of -80% in 2050, the transport sector will need to contribute its share. Most emission reduction potential is expected to come from the de-carbonization of transport fuels (through electric vehicles and hydrogen fuel cells powered by energy from sustainable sources) which represents a big challenge for policy makers in the next decade. Therefore, framework conditions need to be shaped now in order to prepare for a successful market introduction of those innovative transport technologies with high carbon abatement potential.

For more details about effective policy instruments see Bunzeck et al, 2010.

Perceptions from econometric analyses

There is often the argument that car drivers are not sensitive to fuel prices and hence a tax does not have an impact on fuel consumption and does not lead to fuel savings. There are at least two arguments against this statement:

- Fuel demand in Europe is significantly lower than in the USA (where fuels are not taxed);
- Analyses by several authors in the literature show that price elasticity is in a range of -0.3 to -0.6 leads to energy savings of 30% to 60% due to the introduction of a tax.

We think that these two arguments are sufficient to justify the introduction of a higher tax.

Yet, to provide sound evidence for the impact of price, income and fuel intensities (as a proxy for efficiency) in Europe we conducted econometric time series analyses, see Ajanovic/Haas, 2011.

We extracted a long-term price elasticity of about -0.42 for the service vehicle km driven. This result has the following implications: Let us first look what happens if we improve the fuel intensity e.g. due to technical standards. The result is that the service price for vkm driven decreases and driving gets cheaper. Straightforward the price elasticity of -0.42 implies a so-called rebound effect of 42%. That is to say, if efficiency is improved by 1% the number of km driven is enhanced by 0.42% and the remaining energy conservation effect is only 0.58% (see ΔE_η in Figure 5)[1].

This effect can be compensated more or less, by the simultaneous introduction of a fuel tax, as shown in Figure 5. In this case an additional tax – increasing the price P_{s1} to P_{s2} for the service km driven – would fully compensate the rebound and for the owner of a new car the service price would remain the same ($P_{s2} = P_{s0}$).

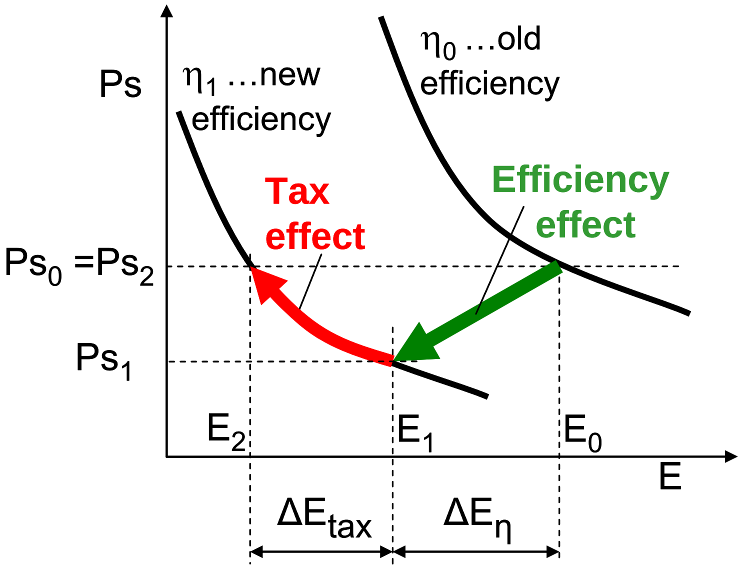

Figure 5. How taxes and standards interact and how they can be implemented in a combined optimal way for society

Which measures contribute to CO_2 reduction and to which costs?

The most important policy measures for the reduction of CO_2 emissions in passenger road transport according to EU goals for 2020 are fuel tax, standards, biofuels, registration tax and E-mobility. With an appropriate mix of these measures in an Ambitious policy scenario we can reduce CO_2 emissions in 2020 for about 100 million tons $CO_{2\text{-eq}}$ comparing to business as usual scenario, see also Ajanovic et al, 2011.

However, the crucial question is of course "How much do European citizens have to pay for achieving these goals?"

In follow we give a survey on the costs of various measures to head towards a least-cost approach. Figure 6 shows the basic principle of a least-cost approach. The different measures are put in a least-cost order including the possible saving potentials up to 2020 for achieving finally 100 million tons CO_2 reduction which corresponds to about 20% CO_2 reduction compared to 2008.

[1] Example: Assume FI of old car was 60 kWh/100 km. If it is improved by 10 % and we have initially 10000 km driven we calculate theoretical savings of 60/100 * 0.1 * 10000 = 600 kWh. Yet, due to the rebound – now we drive 420 km (=10000 * 0.42 * 0.1) more, this is 10420 km – we now save only 348 kWh (=58% of 600 kWh).

The method of approach of identifying these costs is based on calculation of total costs for society and resulting CO_2 reductions:

- For taxes these costs are the over-all welfare losses for society due to a tax divided by CO_2 savings;
- For the technologies we consider the additional investment costs of the technology and the energy cost reduction for the customers (purchasers of cars) respectively the increased producer surplus if the technology is produced in the region;
- For alternative fuels we have to consider the additional production costs minus the increased producer surplus if the technology is produced in the region.

For the last two categories it is furthermore important to consider the technological learning effect. Moreover, we have assumed that 75% of the value chain of new technologies is produced within the EU countries and hence these additional costs are converted into producer surplus.

The CO_2 reduction effects and the corresponding costs of the measures considered in the above categories for the aggregate of EU-15 countries are depicted in Figure 6.

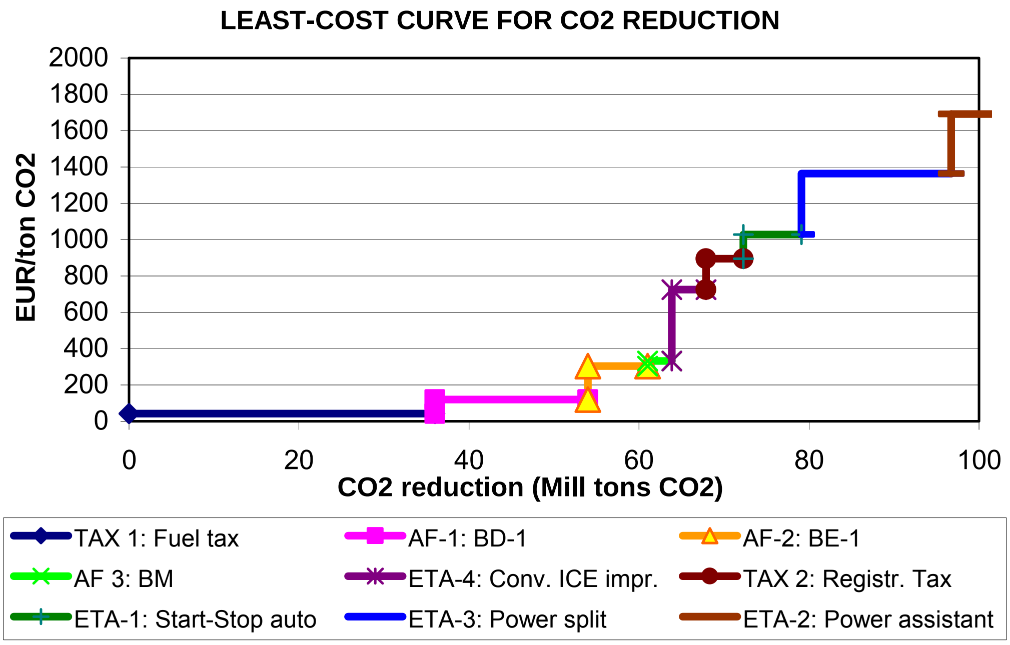

Figure 6. Least-cost curve for CO_2 reduction in passenger car transport in the EU-15 in 2010

The major result of this analysis is that the costs of taxes up to 36 million tons CO_2 reduction at a price of about 40 EUR/ton CO_2 are cheapest for society. So reducing especially the vkm driven and valuing the corresponding welfare loss has the first priority. Next cheapest is switch to biofuels first generation – biodiesel, bioethanol and biogas (BM). This implies that by 2020 biofuels save at least 70% CO_2 compared to fossil fuels. Based on this pre-condition these biofuels in our scenario save 28 million tons CO_2 at costs between 180 and 350 EUR/ton CO_2. Measures of technical efficiency improvements – starting with start/stop automatics, over electric power assistants (mild hybrids) to power splits (full hybrids) and efficiency improvements of the classical gasoline and diesel engine – are in the range of about 1000 to 1500 EUR/ton CO_2. The most expensive measures are to promote fuel cell cars and battery electric vehicles with saving costs above 2000 EUR/ton CO_2. This is the reason why neither BEV nor FCV show up in this figure for least-cost reduction of 100 million tons CO_2. Also BF 2nd generation are not among the least-cost solutions up to 2020 and do, hence, not show up in Figure 6.

Yet, most of these technological solutions are still in the early phase of market introduction. Given that a continuous adaptation of these technologies takes place up to 2020 a remarkable cost reduction of these technologies is possible. However, even if this takes place up to 2020 fuel tax will remain the cheapest solution for CO_2 reductions.

The principle of the cost calculations can be visualized by means of the following example. We analyze the costs of hybrid electric vehicles. They save about 0.9 litre gasoline per 100 km. With a driving distance of 12000 km this is 108 litre/car and year or 252 kg $CO_{2\text{-eq}}$. The corresponding investment costs are 1700 EUR/car or 340 EUR/car/year with a capital recovery factor (C.R.F) of 0.2. Assuming that 75% of this investment contributes to producer surplus of the European companies, the costs are 85 EUR/0.25 ton $CO_{2\text{-eq}}$, this is about 340 EUR/ton $CO_{2\text{-eq}}$.

A result of Figure 6 is that the quantities of the measures fit very good with the shares of our ambitious scenario analysis. However, neither BEV nor FCV show up in this figure for least-cost reduction of 100 million tons CO_2.

An important aspect is that a specific least-cost measure could be the voluntary change to smaller cars. However, this measure must be brought about by changes in awareness and not only by financial incentives.

The costs of fuel taxes C_{CO2_FT} for society are calculated as:

$$C_{CO_2\_FT} = \frac{\Delta C_{FT}}{\Delta CO_{2\_FT}} = \frac{\tau \cdot \Delta E}{2 \cdot \Delta E \cdot f_{CO_2}} = \frac{\tau}{2 \cdot f_{CO_2}} \qquad (4)$$

with:

ΔC_{FT}……..Costs of a fuel tax (EUR);

ΔCO_{2_FT}… CO_2 reduction of a fuel tax (tons $CO_{2\text{-eq}}$)

τ………… Fuel tax

The costs of a new car technology or an efficiency improvement of cars is calculated as:

$$C_{CO_2\_ETA} = \frac{\Delta C_{ETA}}{\Delta CO_{2\_ETA}} = \frac{\Delta IC_{ETA} \cdot C.R.F. + (FI_i vkm_i P_i - FI_j vkm_j P_j) - \Delta PS}{(E_j f_{CO_2\_j} - E_i f_{CO_2\_i})} \qquad (5)$$

with:

ΔIC_{ETA}.....Investment costs of a new technology (EUR);

ΔPS……...Producer surplus

For new technologies we have mainly focusing on procurement policies. That is to say, the cars are purchased by companies like electric utilities, car-sharing firms and not primarily by individuals.

The costs of alternative fuels for society are:

$$C_{CO_2\_AF} = \frac{\Delta C_{AF}}{\Delta CO_{2\_AF}} = \frac{(C_{BF} - C_{FF})\Delta E_{BF}}{\Delta E_{BF}(f_{CO_2\_FF} - f_{CO_2\_BF})} \qquad (6)$$

Conclusions

The major conclusion of this analysis is that technological solutions alone are a very expensive strategy for reducing CO_2 emissions. It is in any case of introducing standards highly recommended to accompany them with taxes. Regarding BEV and fuel cell cars up to 2020 no CO_2 savings at reasonable costs for society will be achieved.

However, improving energy efficiency alone does not necessarily lead to an equivalent energy and CO_2 saving effect. We have seen this problem in recent years in passenger car transport from two major features:

- Europeans purchased larger cars which reduced savings that were expected due to efficiency improvements by about half;
- Car owners increased vehicle km driven – to some extent due to lower service prices due to lower fuel intensity (but also due to increase in income).

As a consequence, these CO_2 emission standards will also lead to cheaper costs per km driven and hence, as one response, to more driving activities and larger cars. So a very important aspect is that accompanying to standards there is an additional focus on energy conservation by introducing fuel taxes.

The measures described are also important because of the following sobering conclusions with respect to the future contributions of alternative fuels and alternative automotive technologies (AAMT). These are:

- Regarding biofuels the potentials of BF-1 are to a large extent already exhausted, especially for BD-1 and BE-1. Moreover, they have to prove a better ecological performance up to 2020 to be considered seriously as CO_2 mitigating fuels. The market prospects of BF-2 today are very uncertain. The major problems are the currently still very high capital costs and the lack of continuous deployment of large production plants. Up to 2020 there are no signs that they will enter the market in considerable amounts.
- With respect to AAMT the potentials for market penetration and CO_2 reduction of BEV and FCV up to 2020 are very limited. If they may reach in a very optimistic scenario 1% market share by 2020 they will straightforward only contribute at the maximum in the same range to CO_2 reduction. This will not provide a significant contribution to the EU's 2020 CO_2 reduction target.

So two final statements are important:

- Firstly, of course, in the long-term only a very broad portfolio of policy instruments (taxes, standards, quotas, emissions free-zones…) and new technologies (BEV, FCV …) can reduce energy consumption and straightforward CO_2 emissions significantly. Yet, there will not be any measure or technology that has the capability to solve all problems alone;
- Secondly, it is currently of urgent importance that there is a clear focus on implementing the two instruments with highest short-term effects: standards and taxes. And a simple but very important key message is that the intended targets and policies are pursued more strictly and more tight and continuous pressure is put on the involved stakeholders: European and national policy makers, car manufacturing companies and also European citizens regarding their driving and car purchase behaviour.

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