Deriving Least-Cost Policy Strategies for Meeting CO$_2$-Reduction Targets in Passenger Car Transport in the EU-15

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ALTER-MOTIVE

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Introduction

GREENHOUSE GAS EMISSIONS EU-27

- Energy sector: 40%
- Industry: 16%
- Service: 4%
- Residential: 11%
- Others: 4%
- ROAD TRANSPORT: 25%
- Energy sector: 40%
- Industry: 16%
- Service: 4%
- Residential: 11%
- Others: 4%
- Railways: 0%
- Ships: 1%
- Other: 0%

TOTAL ENERGY 2007: 4000 Mio tons CO2_equ
The challenges for EU climate and energy policies
Introduction

The three pillars of the Community strategy

- The car industry’s voluntary commitments
- Consumer information
- The promotion of fuel efficient cars via fiscal measures

The three pillars of the Community strategy
Introduction

Evolution of CO2 emissions from new passenger cars by the European (ACEA), Japanese (JAMA) and Korean (KAMA) car manufacturer associations.
Recent developments in passenger road transport

Biofuels production

Recent trends in biofuels production in EU-27 (Data source: EBTP, 2011)
Biofuels production

Comparison of biofuel production in 2009 in EU-27 countries (Data source: EBTP, 2011)
Development of fuel prices

Weighted fuel prices (including all taxes) for EU countries 1980 – 2010 (in prices of 2010, numbers for 2010 preliminary) (Source: EEP; IEA, 2010)
Development of fuel prices

Development of car stock

Car ownership per 1000 capita in EU-27 countries 1970 – 2009
(Source: EUROSTAT; ALTER-MOTIVE database)
Share of the stock of diesel cars in total fossil fuel consumption, selected EU countries 1998 vs 2008 (data source: ODYSSEE database; ALTER-MOTIVE database)
CO2 emissions of new cars in EU-countries in 2009 (data source: DB, 2009)
Performance of new registered cars

Development of average CO2 emissions from new passenger cars by fuel in EU-27 countries from 2000 to 2009 (data source: EC, 2010)
The rebound effect
Development of vehicle km driven (vkm), energy consumption and the fuel intensity of the stock of vehicles in EU-15 from 1990 to 2010
Rebound due car size

Average developments of car power (kW) in various EU-15 countries from 1990 to 2010
Development of fuel intensity, power-specific fuel intensity and power (kW) of new vehicles in EU-15 from 1990 to 2009
Rebound due car size

Normalised development (1990=1) of fuel intensity, power-specific fuel intensity and power (kW) of new vehicles in EU-15 from 1990 to 2009
The impact of better FI and switch to larger cars on total passenger car energy consumption
CO₂ emissions in passenger car transport

CO₂ emissions

Energy

CO₂ emissions coefficient

On-road power-specific fuel efficiency

Test-cycle fuel intensity

Driving coefficient behaviour

Total vkm driven

Power (capacity) of car

Lower coefficient for biofuels or electricity

to be reduced e.g. by kW-specific registration tax

to be influenced by fuel taxes or fuel intensity improvements

to be reduced by eco-driving

to be improved by automobile manufacture

Standards

Education

Fuel tax

Registration tax

Subsidies, quotas

Policy instruments

Impact factors on CO₂ emissions in the car passenger transport sector
So we can reduce CO$_2$ emissions by influencing:

- **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).
CO₂ emissions

The method of approach is finally based on calculation of total costs for society and resulting CO₂ 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.
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 – Energy chain

WTW

WTT

TTW

$E_{\text{prim}}$ $E_{\text{fuel}}$ $E_{\text{car}}$ $S_{\text{mobility}}$

$F_{\text{conv}}$

WTW and TTW - conversion in the energy service providing chain
WTT-, TTW- and WTW net CO2 emissions of fossil fuels vs biofuels in 2010 for the average of EU-countries on a WTW basis
CO2 emissions of fossil fuels versus biofuels in 2010 and 2020 for the average of EU countries on a WTW basis
Production costs of fossil fuels versus biofuels excl. taxes in 2010 for the average of EU countries (Source: Toro et al, 2010)
Cost of fossil fuels vs. biofuels incl. and excl. taxes in 2010 vs 2020 for the average of EU-countries
Fossil fuels vs. biofuels production costs (exclusive taxes) and WTW CO2 emissions, 2010 and 2020
Improving Efficiency

Comparison of specific CO2 emissions of conventional and hybrid gasoline and diesel vehicles with pure BEV based on different electricity generation mixes and FCV with hydrogen
Improve - Efficiency

Comparison of specific CO2 emissions and driving costs
Reduce – Standards & taxes

Reduce

Evolution of CO2 emissions from new passenger cars by manufacturer associations (EC, 2010)

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

- Business as Usual Scenario
- Ambitious Policy Scenario
Historical price developments and assumptions for price development in the scenarios up to 2020

Price increase assumptions:
- Fossil fuels: +3%/yr
- Feedstocks: +2%/yr
- Wood products: +1%/yr
Historical developments of prices incl. and excl. taxes and development in the fiscal policy scenarios up to 2020
0. Historical development
1. Assumptions about future development of income and fuel price
2. Energy consumption
3. Travel distance (vkm)
4. Fuel intensity
5. Number of cars (stock)
6. New registered cars (1000/yr)
7. Fuel price (w and w/o tax)
8. Costs of cars (w and w/o tax)
   - Registration tax
   - Ownership tax
   - Procurement of BEV
9. Service price (EUR/km)
10. Size of cars / share of small, medium and large cars
The ALTER-MOTIVE model

\[ V_{ST_t} = V_{ST_{t-1}} \cdot \varphi + V_{ST_{new}} \cdot \delta \frac{V_{ST_t} - V_{ST_{t-1}}}{V_{ST_{t-1}}} \]

\[ E = vkm \cdot F_I \]

\[ F_I = \frac{F_{I_s}V_{ST_s} + F_{I_m}V_{ST_m} + F_{I_l}V_{ST_l}}{V_{ST_s} + V_{ST_m} + V_{ST_l}} \]
Which measures contribute to CO2 reduction ... 
... and at which costs?

Least-cost curve for CO2 reduction in passenger car transport in the EU-15
Actions that should be implemented immediately are:

- Introduce a green bonus scheme for CO\textsubscript{2} reduction in passenger transport
  
  It is to introduce a green bonus/malus system for every citizen that provides monetary incentives for car sharing, turning-in or not owning a car (incl. scrapping scheme), using low-emission highly efficient vehicles and including (plus and minus) links to an ownership tax and to the use of public transport.
  
  This system will work like an annual tax declaration and can be seen as a forerunner for a personal carbon allowances system.

- Convert fuel taxes to CO\textsubscript{2} based tax and adapt at a 5\% higher level per year
Priorities of actions today, up to 2020 and beyond

- **New vehicles: tighten requirements to the car manufacturing industry**
  Standards for the aggregate of all segments of sold vehicles in every country should be enforced by 6% per year.
  The major effect could mainly come about from a switch to smaller cars. In this context it is important that car producers are further committed to market a higher share of smart cars with less kW and lower CO₂ emissions.

- **Implement a size-dependent registration fee for cars**
  A size-dependent registration fee for cars would provide a monetary incentive for customers to purchase smaller cars.

- **Continue to procure case studies**
Priorities of actions today, up to 2020 and beyond

Actions that should be implemented up to 2020 are:

- Develop infrastructure for “emission free” vehicles
- Biofuels first generation: tighten standards – ensure better ecological performance

Actions that focus on the long run, after 2020 are:

- Emphasize efficient R&D for second generation biofuels and hydrogen
Conclusions

• **Technological solutions** alone are a very expensive strategy for reducing CO\(_2\) emissions.

• Regarding **BEV and fuel cell cars** up to 2020 no CO\(_2\) savings at reasonable costs for society will be achieved.

• **Short-term:** focus on standards and taxes
• **Long-term:** only a very broad portfolio of policy instruments and new technologies can reduce energy consumption and straightforward CO\(_2\) emissions significantly.