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The Economics of Vehicle Emission Standards

Overview and Application to Europe

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Agenda

- **Introduction**
- **Economic Rationale of Vehicle Emission Standards**
- **Assessment Criteria**
- **General Properties**
- **Specific Issues of Implementation**
- **Situation and Perspectives for Europe**
- **Conclusion**

Introduction

- **Climate change has moved to the top of the political agenda**

- **Transport is a major contributor of Greenhouse Gases (GHG): It accounts for roughly a quarter of the CO_2-emissions in Europe and the OECD, whereof the major part originates from road transport**

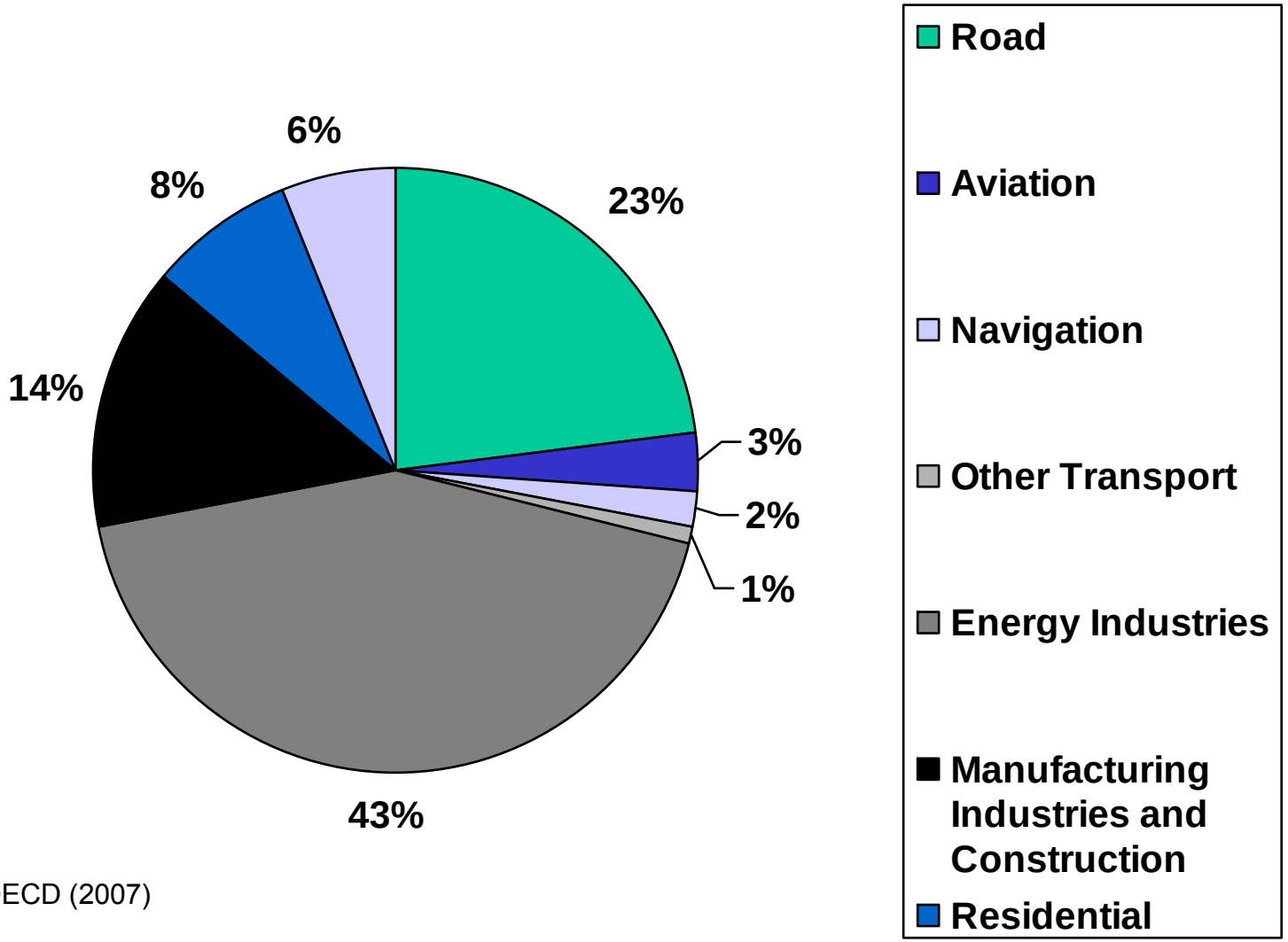
- **While most sectors could reduce their emissions over the past years, transport's emission have significantly increased**

- **Thus, transportation has increasingly moved into the focus of climate policy in order to take its responsibility**

- **Targets of the voluntary commitments of the German as well as the European automobile industry to reduce specific CO_2-emissions of passenger cars (140 g CO_2/ km by 2008) will not be achieved**

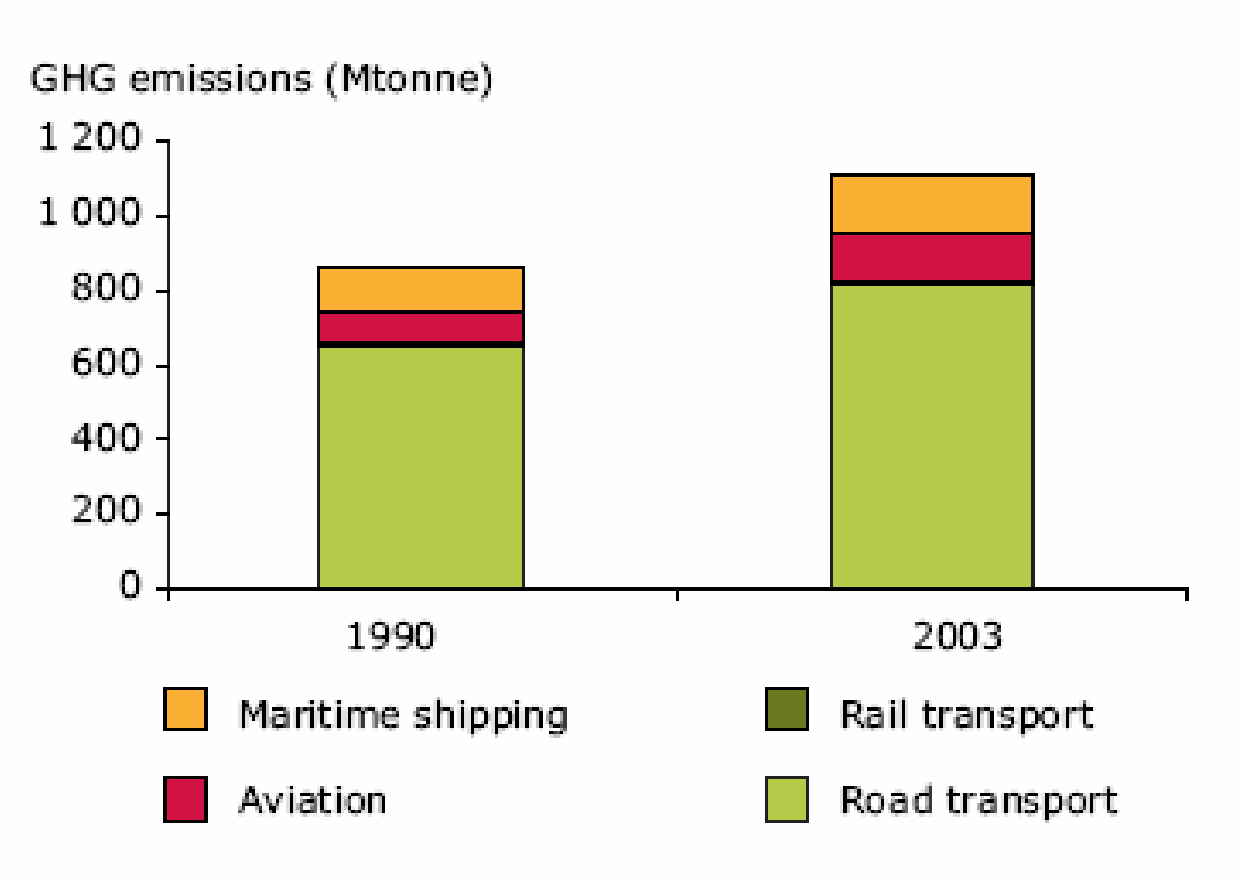
- **The EU has announced to implement mandatory legislation in order to limit the average CO_2-emissions of new cars to 130 g CO_2 per km**

Transport's Share of CO_2-Emissions in the OECD



Source: OECD (2007)

Transport's GHG-Emissions by Mode in EEA countries



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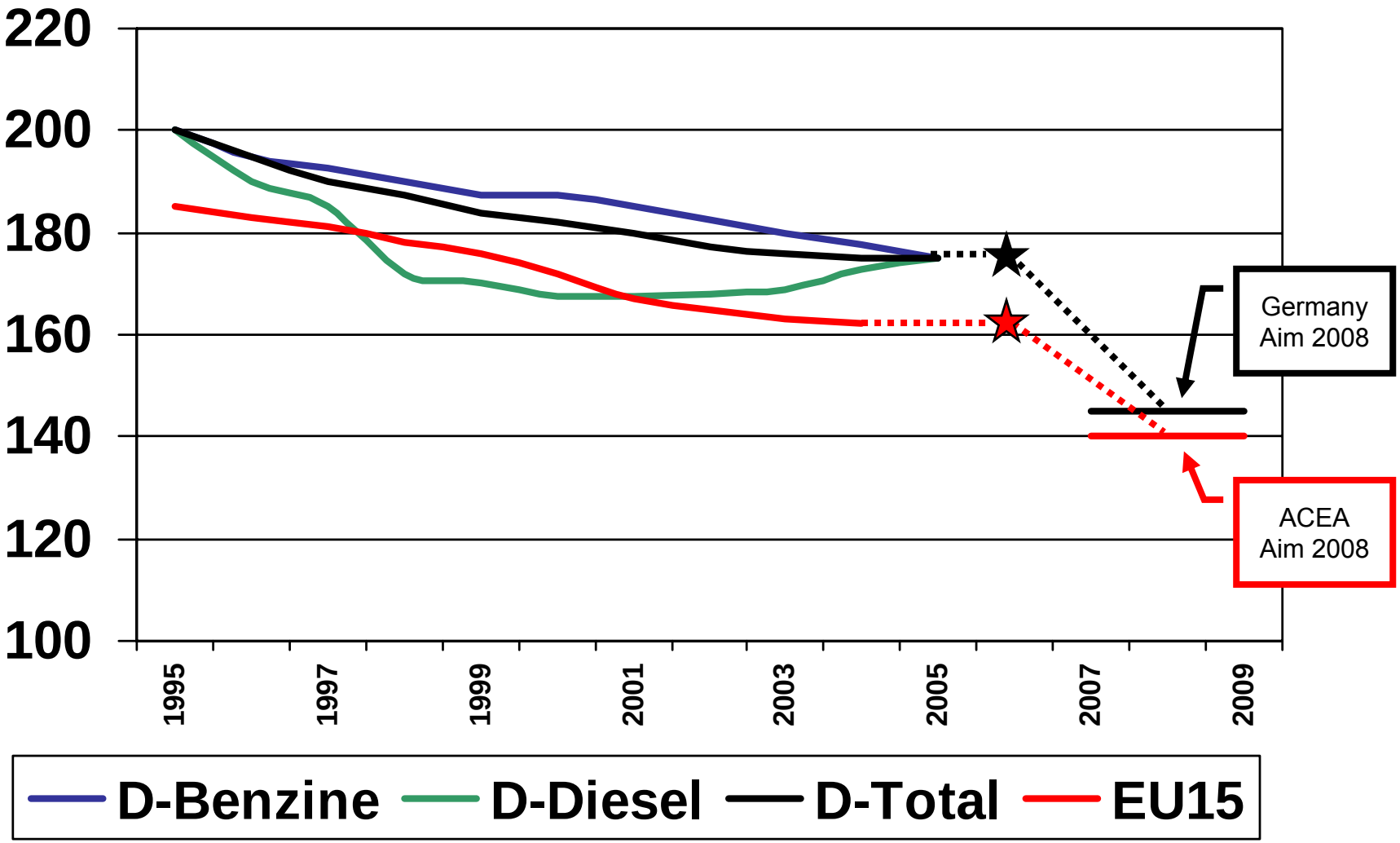
Specific CO_2 Emissions of Newly Registered Vehicles since 1995



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Economic Rationale of Vehicle Emission Standards

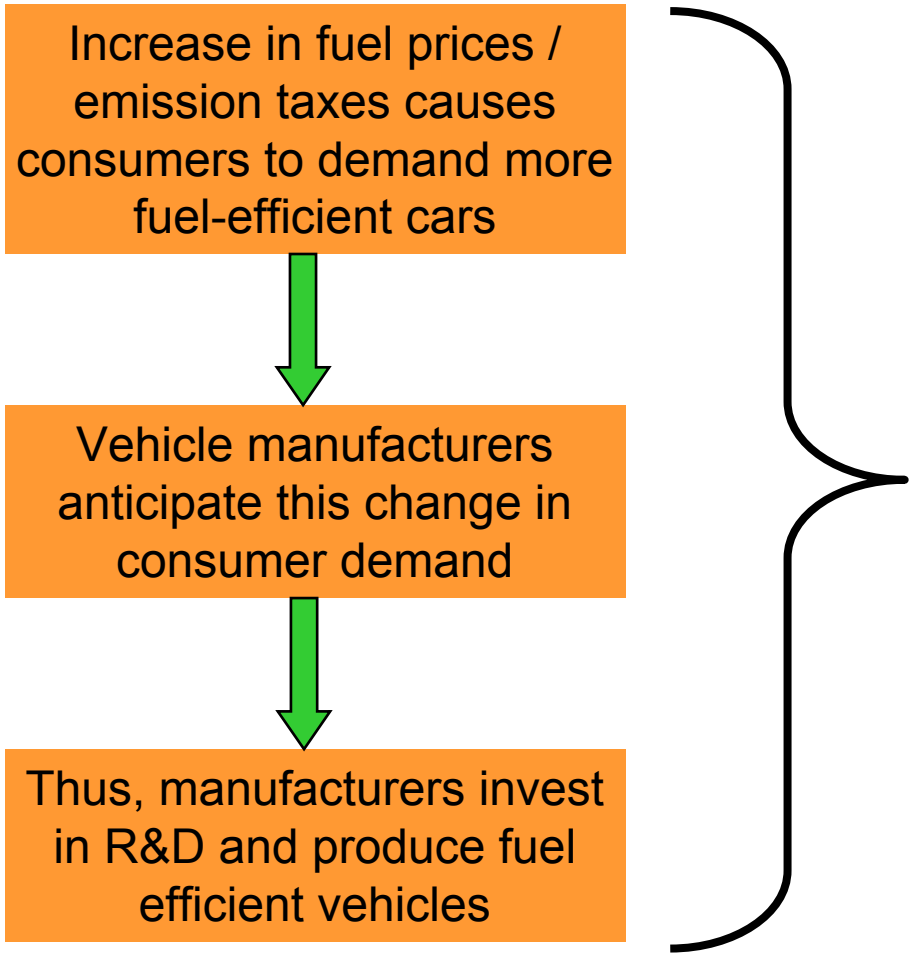
- **Vehicle emissions standards are a regulatory instrument that aims at**
  - Increasing fuel efficiency
  - Reduction of CO_2-emissions
  - Reduction of oil dependency

- **Under optimal market conditions transmitted price signals (fuel taxes/emissions taxes) facilitate the achievement of the desired targets**

- **If market fails in giving the right incentives, investments in R&D for cleaner technologies and the early implementation of low-carbon technologies may be procrastinated**
  - Procrastinated current investments increase the future marginal abatement cost
  - Suboptimal intertemporal abatement path

- **Moreover, lacking political feasibility could hamper the implementation of a comprehensive carbon pricing scheme for the transport sector**
  - legal constraints, resistance by industry lobby groups or NGOs, „fairness“ argument“

Economic Rationale of Vehicle Emission Standards



Imperfect market conditions at each of these levels could impair the transmission of the price signals and may lead to suboptimal market development

Economic Rationale of Vehicle Emission Standards

Consumer:

- Uncertainty about future fuel prices
- Myopic foresight
  - **Consumer make irrational decisions: consumers do not take future fuel costs appropriately into account**
- Excessive discount rates
  - **Consumers (even non-myopic ones) discount future fuel savings of efficient vehicles at higher rates than the socially optimal discount rate**
    - **lacking policy credibility impacts fuel expectations, resale**

•Manufacturers

- Uncertainty about future demand and prospective climate policy (credibility problem)
- Managers aim at short time profit maximization in order to increase own income instead of long-term optimization
- Spill-overs / positive externalities of innovations
  - **If know-how and resulting benefits of "green" innovations disperse without adequate compensation, such investments will be hampered**

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Assessment Criteria

Economic Efficiency

- **Static efficiency**
  - Achievement of a given reduction target at least abatement costs. i.e. equalization of the marginal abatement costs at all emission sources

- **Transaction costs**
  - Costs of implementation and enforcement of the climate policy measure

- **Side effects**
  - Externalities of emission reduction measures, i.e. costs and benefits that are not directly related to the abatement of CO_2-emission (e.g. local pollution, congestion, urban livability, etc.)

- **Dynamic efficiency**
  - Provision of incentives to invest in innovations for low carbon technologies
  - R&D investments reduce prospective abatement costs in order to meet an intertemporally optimal abatement path

Assessment Criteria

Environmental effectiveness

- Extent of absolute emission reduction, precision of emission control

Substitution and Leakage

- Changes in CO_2-emissions levels outside the covered scope caused by the respective policy measure
- Example: Potential relocation of energy intensive industries outside the ETS

Distributional Effects

- Incidence of cost (and benefits) of climate change policy within the covered economies as well as between industrialized, emerging, and developing countries

Political Feasibility

- Legal constraints
- resistance by industry lobby groups or NGOs, „fairness“ argument“

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General Properties of Vehicle Emission Standards

Static Efficiency

- **Vehicle emission standards cannot bring about static efficient results**
  - This would require the assignment of individual standards that equalize the marginal abatement costs for each vehicle model
  - Regulatory bodies do not have information about the characteristics of the respective abatement costs functions

Transaction costs

- **TC are related to the concrete design, but they are expected to be manageable**

Side effects

- **Potentially positive effect on local pollutant due to fewer fuel combustion**
- **Possibly negative effect on congestion (rebound effect)**
- **Impact on safety is unclear - influencing variables: changed vehicle weight, more traffic**

Dynamic efficiency

- **Incentive or rather obligation to increase fuel efficiency**
- **However, concrete design is crucial for the dynamic efficiency**

General Properties of Vehicle Emission Standards

Substitution and Leakage

- Leakage is of minor importance due to narrow scope for substitution

Distributional effects

- The pass-through of additional production and R&D costs to consumers depends on the price elasticity of automobile supply and demand
- The distribution of costs between manufacturers depends on the design details (reference parameter)

Political feasibility

- Crucially depended on the implementation details

Environmental effectiveness

- Vehicle emission standards are capable of inducing significant emission reductions
- However, a major criticism of vehicle emissions standards is their insufficient precision in emission control
- Dependent on the implementation details even the CO_2-emissions per vehicle kilometer are not precisely controllable

General Properties of Vehicle Emission Standards

(Unweighted) Vehicle Emission Standard:

$$VES^{Fleet} = \frac{\sum_i \left[\left(\frac{CO_2}{km} \right)_i^{VES} \cdot X_i \right]}{\sum_i X_i}$$

i=1,…,n Vehicle model

General Properties of Vehicle Emission Standards

Actual absolute emissions of the fleet:

$$E = \sum_i \left[\left(\left(\frac{CO_2}{km} \right)_i^{VES} + \varepsilon_i \right) \cdot X_i \cdot km_i \right] + E^{old}$$

subject to uncertainty

i=1,…,n	Vehicle models
X_i	Sold vehicles of model type i
km_i	Specific Mileage of model type i
ε_i	Deviation of actual emissions per km from measured emissions per km (due to driving behaviour, peripheral components, congestion, etc) for model type i
E^{old}	Emissions of the existing old fleet

General Properties of Vehicle Emission Standards

Actual average fleet emissions per km:

$$VES^{act} = \sum_i \left[\left(\left(\frac{CO_2}{km} \right)_i^{VES} + \varepsilon_i \right) \cdot \frac{X_i \cdot km_i}{\sum_i (X_i \cdot km_i)} \right]$$

subject to uncertainty

Weighting factor

i=1,…,n	Vehicle models
X_i	Sold vehicles of model type i
km_i	Specific Mileage of model type i
ε_i	Deviation of actual emissions per km from measured emissions per km (due to driving behaviour, peripheral components, congestion, etc) for model type i

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Specific Issues of Implementation

Level of Compliance

- **Car**
  - No flexibility, no offsetting, excessive costs due to unequal abatement costs
- **Industry**
  - Failure of voluntary commitments by the car manufacturers has shown the ineffectiveness of common targets for the entire industry
- **Manufacturers should be the point of regulation**
  - Clearly assigned responsibility, flexibility through bubbling

Definition of the standard

- **Uniform standards**
- **Performance-based standards**
- **Tradable standards**

Specific Issues of Implementation

Uniform Standards

- **Each manufacturer has to comply individually with the uniform standard of 130 g CO_2 / km average fleet emissions**

- **Economically inefficient as marginal abatement costs of meeting the standard differ significantly between manufacturers**
  - Realistically, uniform standards are not achievable by all manufacturers at reasonable costs
  - Excessive costs to manufacturers of luxury and/or high-performance cars

- **No incentives for producers of small cars to reduce their emissions further after achieving the emission standard**

- **Politically not feasible within the EU as especially manufacturers from the UK and Germany would suffer from uniform standards**

Specific Issues of Implementation

- **Performance-based standards relate the specific emission target of a vehicle to a certain reference parameters**

- **The parameter should refer to the reduction costs and the utility provided by the vehicle**

- **Most countries having vehicle emission standards employ such performance based standards**

- **Risk of missing the targeted emission standard according to a race towards the reference parameter**

- **Potential reference parameters are:**
  - Engine Displacement
  - Rated Power Output
  - Curb Weight
  - Shadow Area
  - Vehicle Volume
  - Interior Volume

Specific Issues of Implementation

- **Engine displacement / rated power output**
  - Closely correlated to emission intensity
  - Statically efficient as high-performance cars have higher marginal abatement costs
  - As baseline increases with the engine displacement / rated power output, no incentives for downsizing are provided
  - Weak political feasibility due to undesired distributional effect: Implicit subsidy for high performance cars
- **Curb Weight**
  - Tight correlation to emission intensity
  - High static efficiency
  - Weight reduction as a major lever for the reduction of emission intensity
  - Curb weight as reference parameter provides counterproductive incentives to increase vehicle weight
- **Shadow Area ("Footprint")**
  - Positive, but weaker correlation to emission intensity
  - Less vulnerable to adjustments of vehicle design in order to boost the baseline due to technical and consumer demand reasons
  - Most appropriate reference parameter: Best compromise in the trade-off between static efficiency and dynamic efficiency

Specific Issues of Implementation

Tradable Standards

- **Emission credits are generate for cars undercutting the respective baseline**
- **Manufacturers whose average CO_2-emissions per km exceed the standard can buy credits from manufacturers emitting below the standard**
- **Static efficiency is given as all manufacturers will adjust their fleets until the marginal abatements costs equal the credit price**
- **Dynamically efficient, because all manufacturers benefit from efficiency improvements**
  - However, dynamic efficiency may decrease according to the choice of the reference parameter in case of a performance-based baseline
- **Distributive effects depend on the baseline definition**
- **Small number of actors in the credit market facilitates the risk of strategic behavior**
- **A lower and an upper boundary of the credit price ensures or alternatively a semi-open link to the ETS could prevent the abuse of market power in the credit market;**

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Background

- **After failure of the voluntary agreements of ACEA, JAMA, KAMA, the mandatory legislation on vehicles CO_2-emissions were announced**
- **In average 130 g CO_2 / km have to be achieved by new cars; supplementary measures should provide an additional reduction of 10 g.**

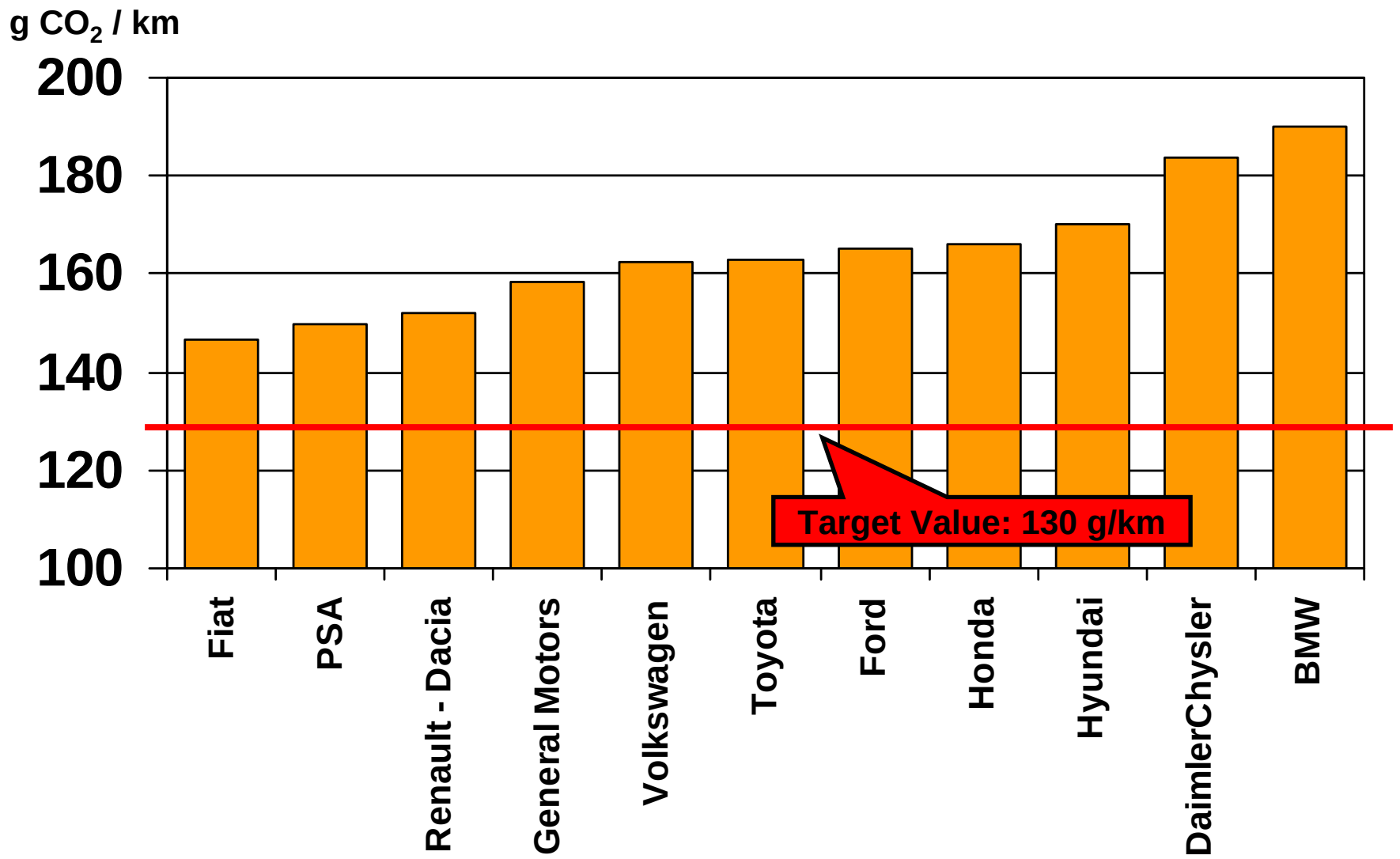
Positions

- **French and Italian manufacturers propose an uniform standard**
- **Manufacturers from Germany and the UK prefer the weight based approach**
- **EP's environment committee has proposed a closed-market mechanism with tradable carbon allowances**

Prospects

- **A uniform standard is very unlikely as the current average emissions of suppliers in the European automobile market differ significantly**
- **The currently most probable implementation option seem to be the weight-based or the footprint-based approach**

Average CO_2-Emission per Vehicle-kilometre (2006)



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Conclusions

- **Transportation is a major contributor to climate change and its emissions are still growing**
- **Thus, the transport sector has to take its climate change responsibility**
- **Price signals (fuel prices) have shown limited effectiveness in improving fuel efficiency and reducing CO_2-emissions from road transport**
  - myopic foresight, high discount rates, etc.
- **Vehicle emission standards are capable of reducing CO_2-emissions from road transport, but do not provide precise emission control**
- **Definition of the reference parameter for performance-based regulation is the crucial design issue**
  - As European vehicle emissions standards are subject to political decision based on national interests, which may lead to inadequate decision providing counterproductive
  - Trade-off between static efficiency and dynamic efficiency
- **Tradable vehicle standards provide the greatest flexibility to market participants**
  - They seem to be the most cost efficient implementation option
  - Unintended incentives can be avoided through non-performance-based baselines
  - A lower and an upper boundary of the credit price ensures incentives for continuous efficiency improvements and prevents the abuse of market power in the credit market

Conclusions

- **Alternative policy measures to correct myopic foresight in the automobile market: CO_2-dependent purchase/ownership taxes (possibly with prepayment) and improved labeling (amendment of Directive 1999/94/EC)**
- **However, all these approaches do not conform with the polluter-pays-principle**

- **Vehicle emission standards can only be a complementary instrument**
- **The concrete implementation details matter**
- **The focus of climate policy for the transport sector has to set on a consistent carbon pricing scheme**

The End…

Thank you very much for your attention!

The floor is open for discussions…