



The project is funded by the European Commission's  
Directorate-General Environment



# EU Transport GHG: Routes to 2050?

## Session 2 - Review of GHG reduction options

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**1<sup>st</sup> Stakeholder Event**  
**Friday 27th March 2009, Brussels**

[www.eustransportghg2050.eu](http://www.eustransportghg2050.eu)

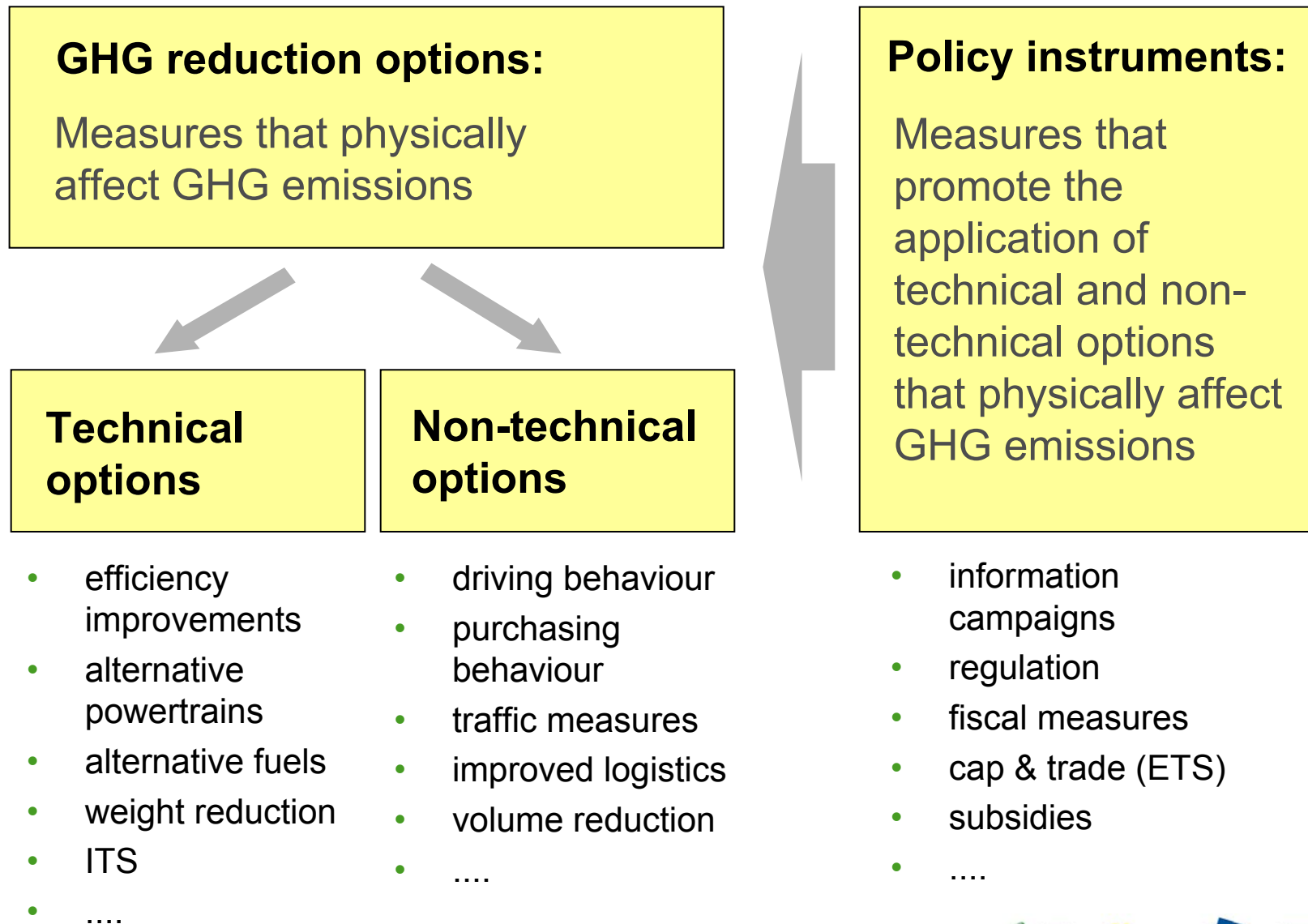


# Purpose of the review

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- element of part I of the project
  - February – August 2009
- overview of available information on GHG reduction options
  - results of studies
  - incl. underlying assumptions on oil price, discount rate, cost reduction
- establish consensus on state-of-the-art insight in readiness, potential and costs of various GHG reduction options
- identification of knowledge gaps
- focus on longer term
  - move beyond the current debate
- provide **quantitative & qualitative** inputs for scenario analysis and cost curves in part II
  - GHG reduction potentials
  - GHG abatement costs (€/tonne of CO<sub>2</sub>-equiv. avoided)

# Review of GHG reduction measures



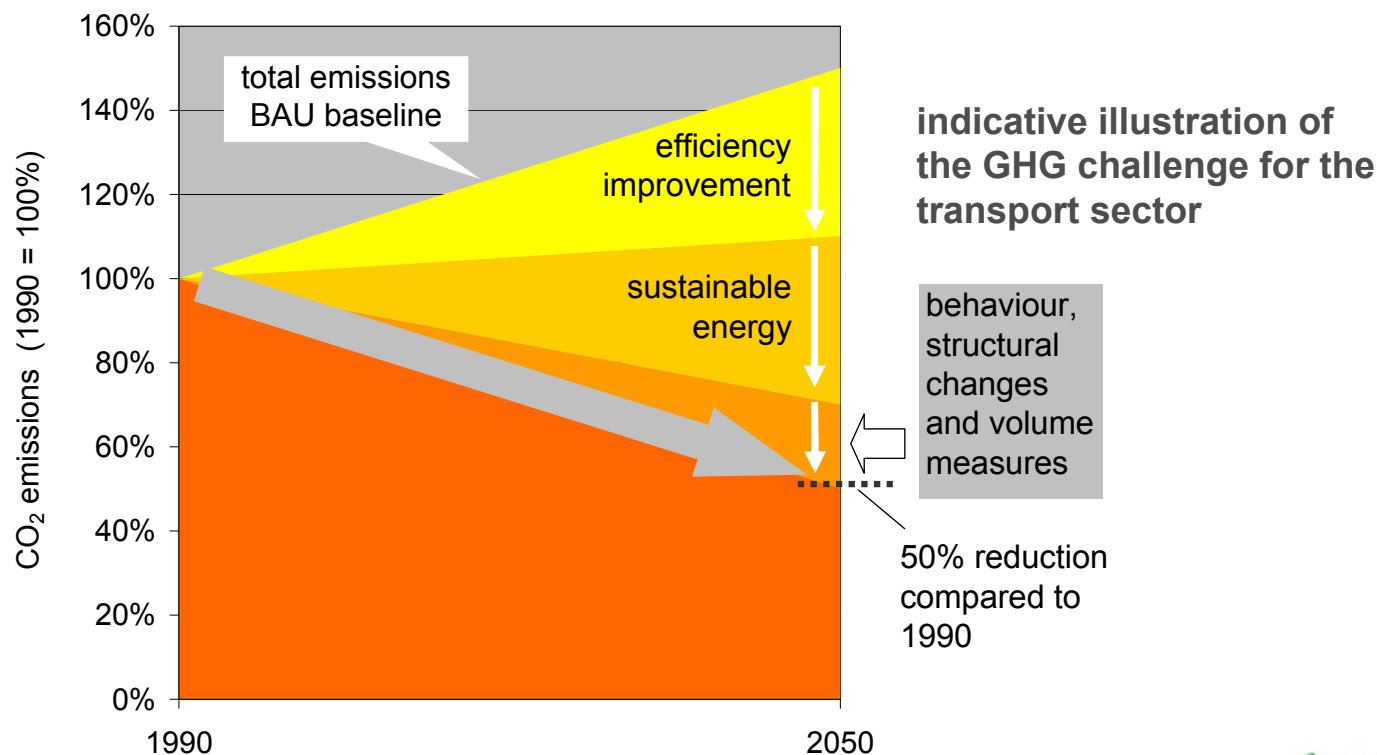
# Review of GHG reduction options

- Trias Energetica

- efficiency
- structure
- volume



- efficiency improvement at vehicle level
- sustainable energy supply
- behavioural and operational measures
- structural changes
- volume changes



# Review of GHG reduction measures

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- Review of available information to create state-of-the-art overview of of GHG reduction measures
  - operating principle
  - potential
  - costs / cost effectiveness
  - feasibility
- Data / information sources
  - literature
  - **stakeholder & expert input**
  - expert knowledge / judgement of consortium
  - own calculations
- Create fact sheets
  - fixed format with headings for various aspects
- Summarize & analyse results in overview papers

# Use of the data in part II

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- Detailed and consistent assessment and comparison of selected measures on the basis of:
  - feasibility
  - effectiveness in reducing GHG emissions
  - efficiency in reducing GHG emissions per € expenditure
  - compatibility with EU and international law and EU objectives
  - profile of GHG emission reductions
  - permanence/durability of GHG emission reductions
  - broader impacts (e.g. economic, social, environmental, including non-transport sectors )
- Exploration of scenarios for selected options and instruments
  - with the help of cost curves as means to illustrate role of different options in scenario
- Development of a prioritisation of options for action at the European level
  - interaction between options and policy instruments

# Topics

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- **technical GHG reduction options for road vehicles**
  - **improved engine efficiency**
    - direct injection / downsizing + turbo / variable valve actuation / HCCI / CAI / start-stop
  - **reduced driving resistances**
    - aerodynamics / tyres / lubricants
  - **weight reduction**
  - **efficient components / auxiliaries**
    - airco / power steering
  - **alternative propulsion systems**
    - (plug-in) hybrid / battery-electric / fuel cell
  - **alternative energy carriers**
    - CNG / various biofuels / electricity / hydrogen
  - **Intelligent Transport Systems**
    - vehicle-to-vehicle & vehicle-to-road interaction
    - road trains / platooning

# Topics

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- non-technical GHG reduction options for road vehicles
  - consumer / user behaviour:
    - fuel efficient driving (both for light-duty and heavy-duty vehicles)
    - tyre pressure monitoring
    - vehicle down-rating (i.e. buying cars with less performance)
    - vehicle downsizing (i.e. buying smaller vehicles)
    - driving less / changing mobility patterns
  - traffic related measures:
    - speed limits
    - synchronized traffic lights
    - advanced traffic management systems
  - efficient goods transport:
    - improved logistics
    - improved urban distribution
  - modal shift
    - from car to public transport or bicycle
    - from trucks & vans to rail / inland shipping / ???

# Topics

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- rail
  - mass reduction
  - regenerative braking
  - electrification
  - improved air conditioning
  
- inland shipping
  - technology:
    - improved hull design
    - fins and flaps
    - more efficient engines and drivelines
    - more efficient screws
    - gas turbines
    - diesel-electric propulsion
    - all electric ships
    - alternative fuels
    - anti-fouling coatings
  - operational:
    - improved maintenance
    - optimal speed
    - improved logistics
    - just in time routing

# Topics

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- inland aviation
  - technology
    - engine efficiency
    - turboprops
    - blended wing
    - winglets / riblets
    - biofuels
  - operational
    - reduced tankering
    - electricity at the gate
    - open skies
    - improved air traffic control
- other measures
  - information services
  - mobility management
  - advanced transport systems
    - shuttles, light-rail, MAGLEV, ???
- review of measures for international aviation and shipping

# Aspects reviewed for GHG reduction options

## Structure of fact sheets (1)

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- application area
  - transport mode / vehicle class
- description
- GHG reduction at vehicle level
- costs at vehicle level
  - additional investment costs
  - other cost changes, e.g. maintenance
- timeframe for application
- potential scale of application
- total GHG abatement potential
  - Mton/year
  - determined by many (scenario) assumptions
- abatement costs / cost effectiveness
  - €/tonCO<sub>2</sub>-equiv.
  - determined by many (scenario) assumptions

# Aspects reviewed for GHG reduction options

## Structure of fact sheets (2)

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- co-benefits
  - air pollutant emissions, noise, safety, congestion, added value to users, etcetera
- infrastructural requirements
  - transport infrastructure
  - energy infrastructure
- barriers for market introduction
- policy instruments that might promote application of this GHG reduction option
- interaction with other GHG reduction options
  - synergies
  - double counting
  - incompatibilities
- uncertainties and main open issues
- other relevant information

# Abatement costs

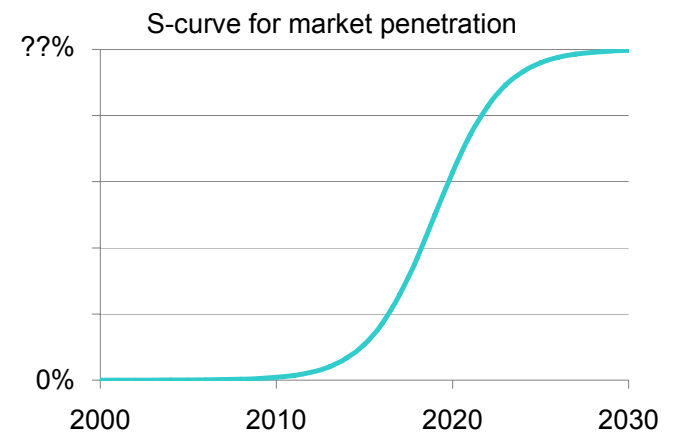
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$$\text{abatement costs} = \frac{\text{additional investment} - \text{fuel cost savings}}{\text{GHG reduction (in CO}_2\text{-equiv.)}}$$

- **determined by:**
  - reference case (baseline) and stacking of options
  - estimated investment costs
    - depends on time horizon
  - estimated fuel consumption reduction / CO<sub>2</sub> reduction per km
  - assumed annual mileage & lifetime of vehicle
  - oil price
  - discount rate for amortisation of costs
- **social vs. user perspective**
  - excl. or incl. taxes
  - different discount rate

# Reduction potential

- determined by scenario assumptions w.r.t.:
  - volume growth in BAU scenario
  - autonomous developments in BAU scenario
  - assumed potential market uptake, depending on:
    - competitiveness of option
    - consumer acceptance
    - rate of investment by industry
    - chicken & egg problems with infrastructure
  - application of other measures
    - competition
    - stacking
- 2<sup>nd</sup> order impacts
  - higher costs leading to reduced mobility or shifts in purchasing behaviour and modal choice
  - rebound effects
    - lower transport costs or reduced travel time leading to increased mobility



# Example of cost curves

Exhibit 8.6.4

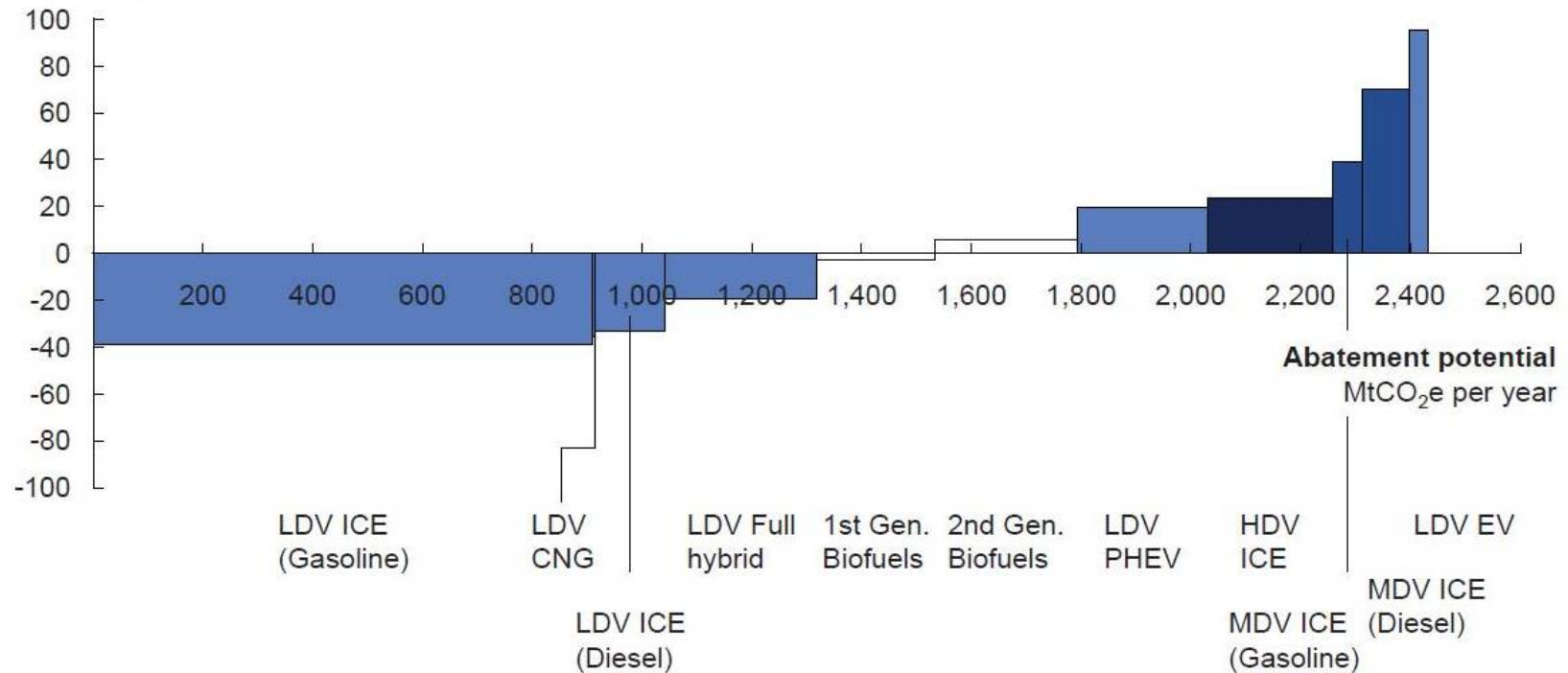
Source: Pathways to a Low Carbon Economy, McKinsey 2009

## Global GHG abatement cost curve for the Road Transport sector – Mix Technology World scenario

Societal perspective; 2030

- Biofuels
- LDV levers
- MDV levers
- HDV levers

Abatement cost  
€ per tCO<sub>2</sub>e

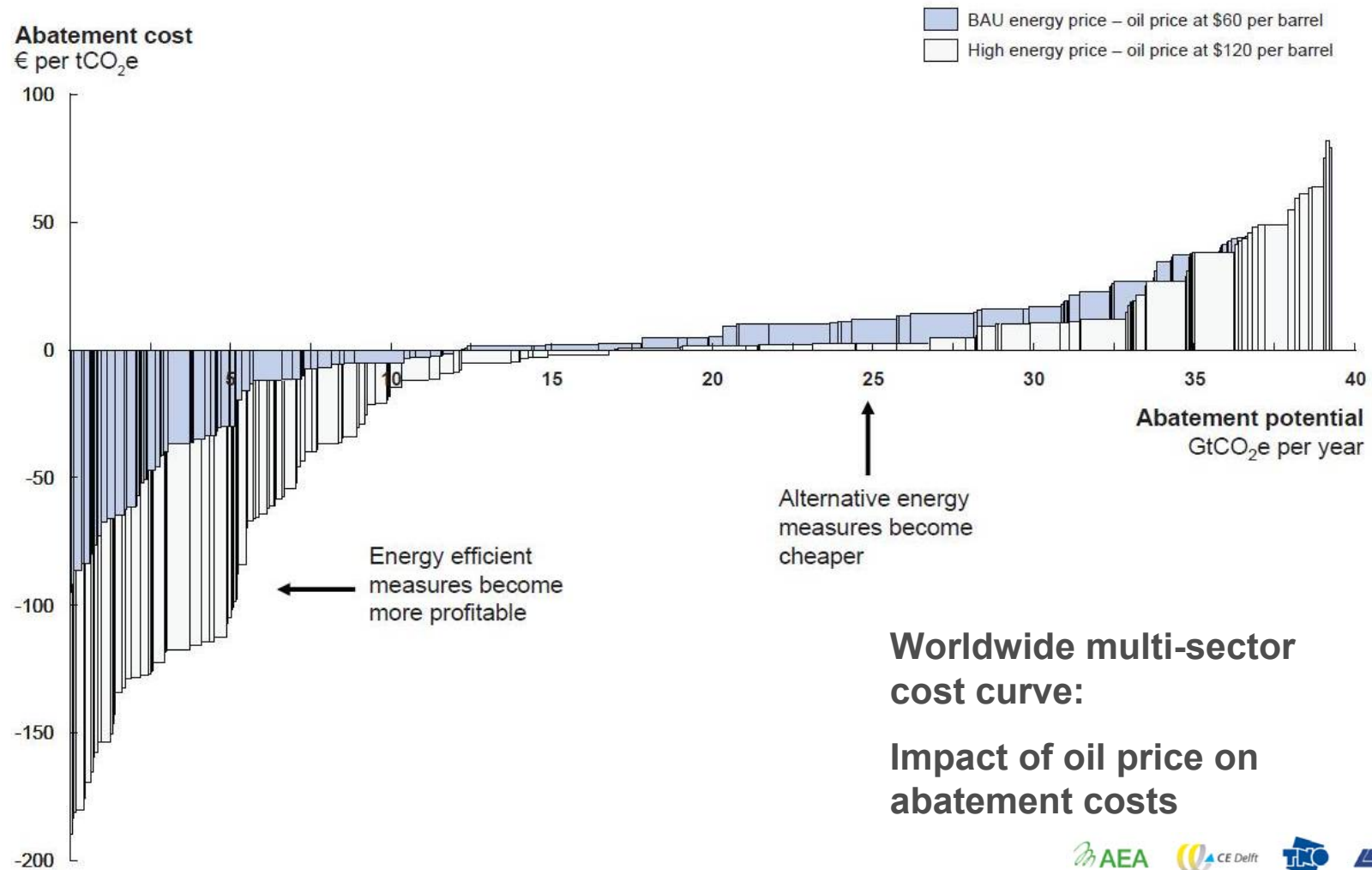


# Impact of oil price

Exhibit 6.2.1

Source: Pathways to a Low Carbon Economy, McKinsey 2009

## Effect of high energy prices (oil price at \$120 a barrel)

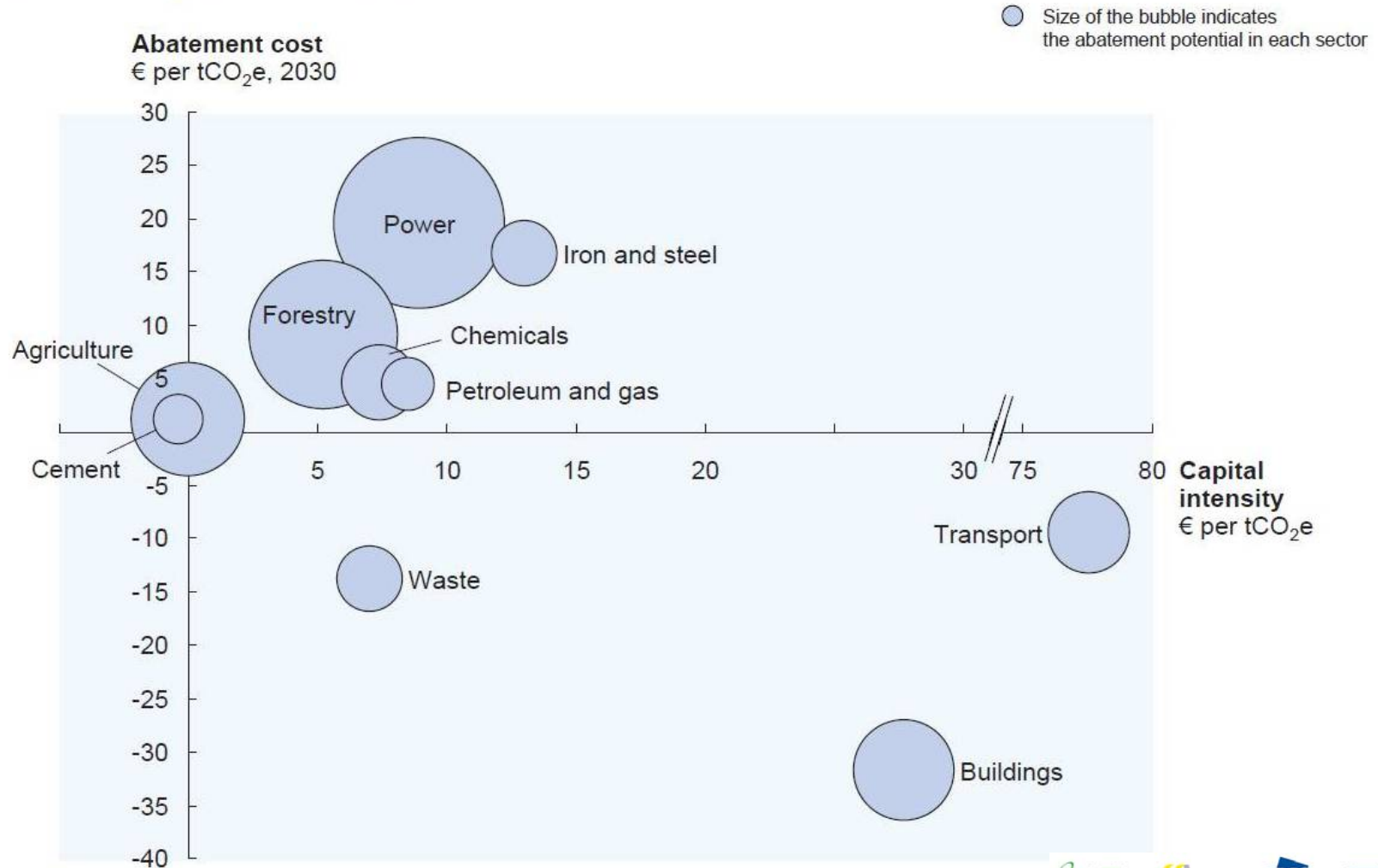


# Abatement costs vs. investment costs

Exhibit 9

Source: Pathways to a Low Carbon Economy, McKinsey 2009

## Capital intensity and abatement cost



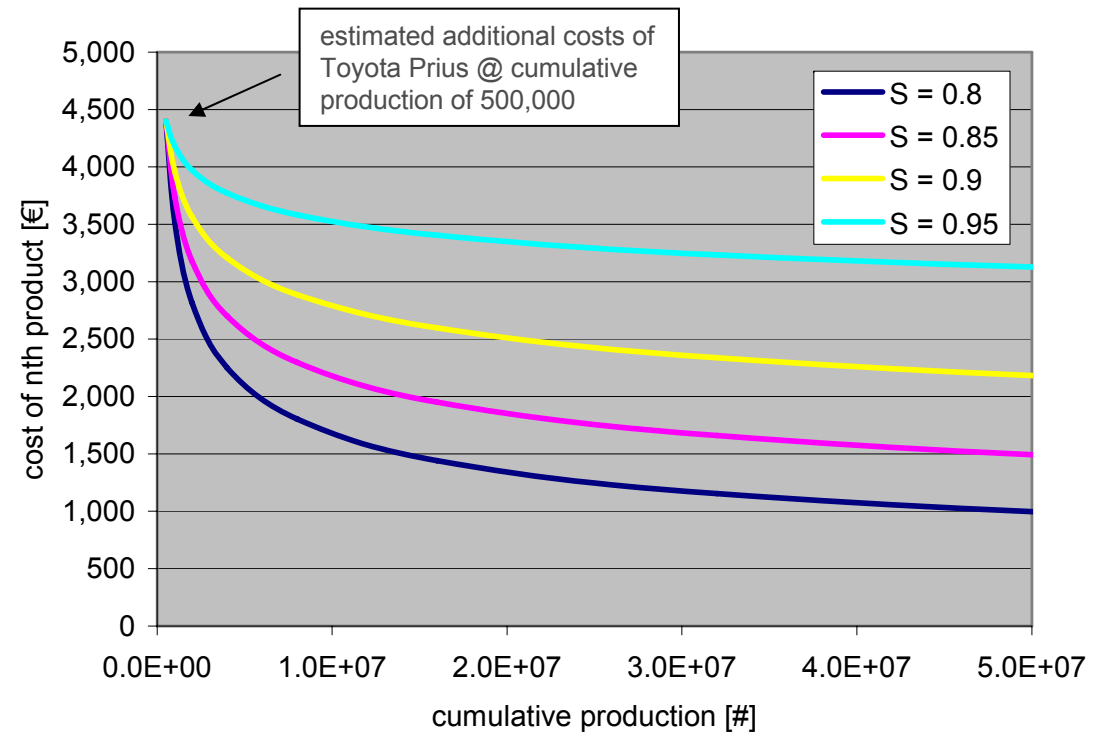
# Challenges

- cost development 2020 - 2050
  - up to 2030 costs can be estimated with some certainty
    - input from industry is useful
  - learning curve theory is soft science
  - innovations are unpredictable

$$C_n = C_1 \times n^{\ln(S)/\ln(2)}$$

$n$  = cumulative production  
 $C_n$  = cost of  $n^{\text{th}}$  product  
 $C_1$  = cost of 1<sup>st</sup> product  
 $S$  = learning rate

learning curve theory applied to hybrid-electric passenger cars



# Challenges

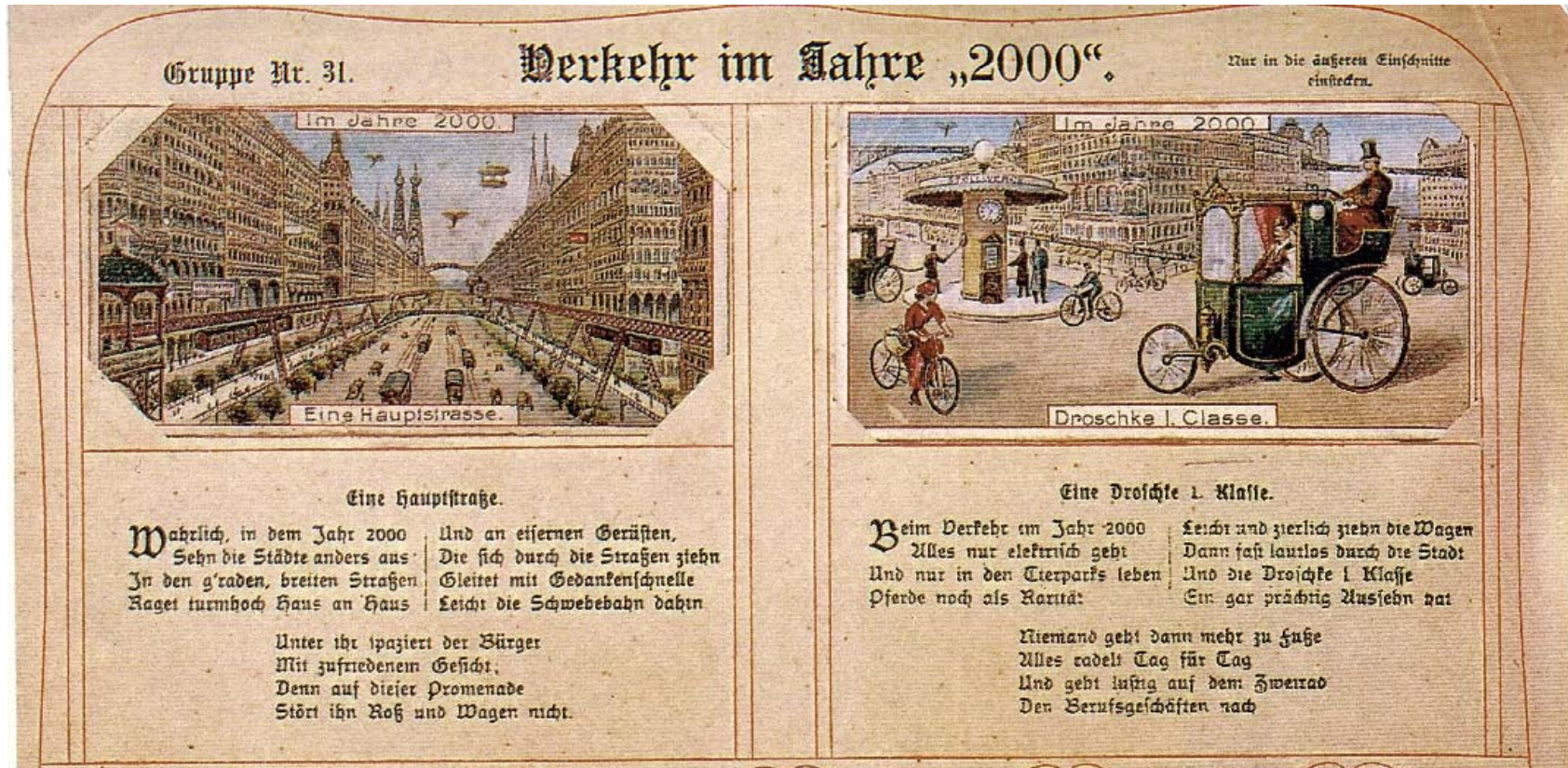
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- how different is 2050 from today?
  - extrapolation / incremental changes:
    - we still drive our own private cars but they are more sustainable
  - “brave new world” / structural changes / transition:
    - with alternative energy supply systems for transport?
    - with smaller cars / different cars?
    - with alternative mobility concepts?
    - with more public transport?
    - with intelligent transport systems?
    - with efficient spatial planning reducing demand or enabling (new) collective transport systems?

## **incremental change ↔ transition**

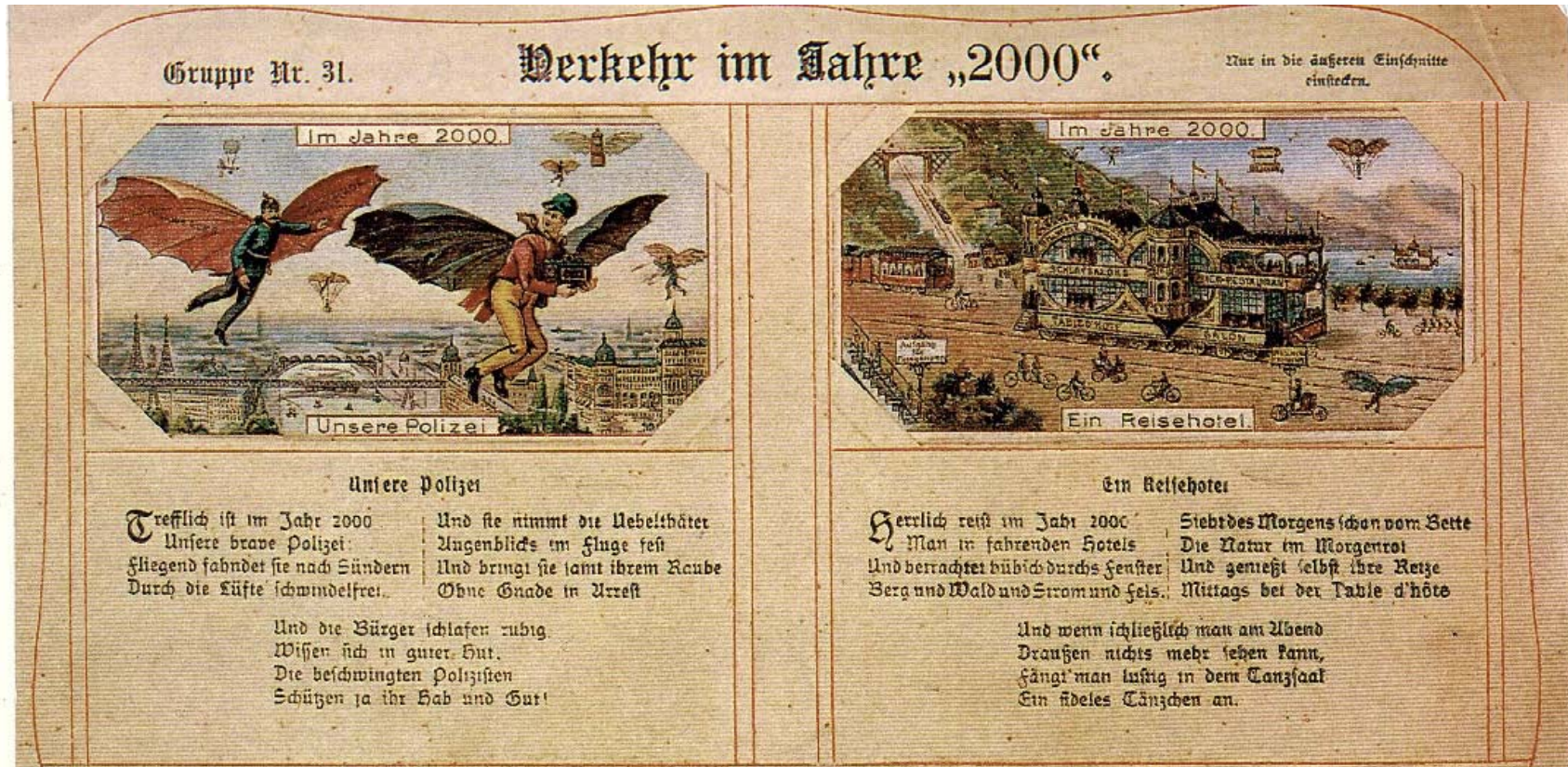
- room for change depends on:
  - inertia in transport system / energy system / built environment
    - lifetime of vehicles and infrastructure

# Challenges



*a vision from 1900*

# Challenges



*a vision from 1900*

# Challenges

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- limitations of analytical approach should not determine the vision on / design of the future of mobility
  - difficulty of quantifying costs and benefits
    - attribution of costs to GHG impact of investments that are made for more purposes than just GHG emission reduction
    - estimating future costs of technology
    - added value of innovative solutions
    - welfare costs of behavioural changes
- integrate structural / system changes into picture of sustainable transport in 2050
  - alternative transport systems
  - alternative mobility concepts
  - European corridors for road, rail & water
  - changes in spatial planning
    - e.g. influencing commuting distances or increasing applicability of collective transport options
  - changes in behaviour
    - buying different / smaller cars
    - travel behaviour

# Information needs

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- suggestions for innovative GHG reduction options for the long term
- additional technical information on GHG reduction options
  - recent studies
  - expert information
  - quantitative and qualitative information
- stakeholder and expert opinions on non-technical issues related to GHG reduction options
  - readiness of options
  - lead time for large scale application
  - long term perspectives of options
  - visions on structure of the transport system in 2050
    - dominant transport modes
    - dominant propulsion systems & energy carriers

## Session 2 - Review of GHG reduction options

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# DISCUSSION

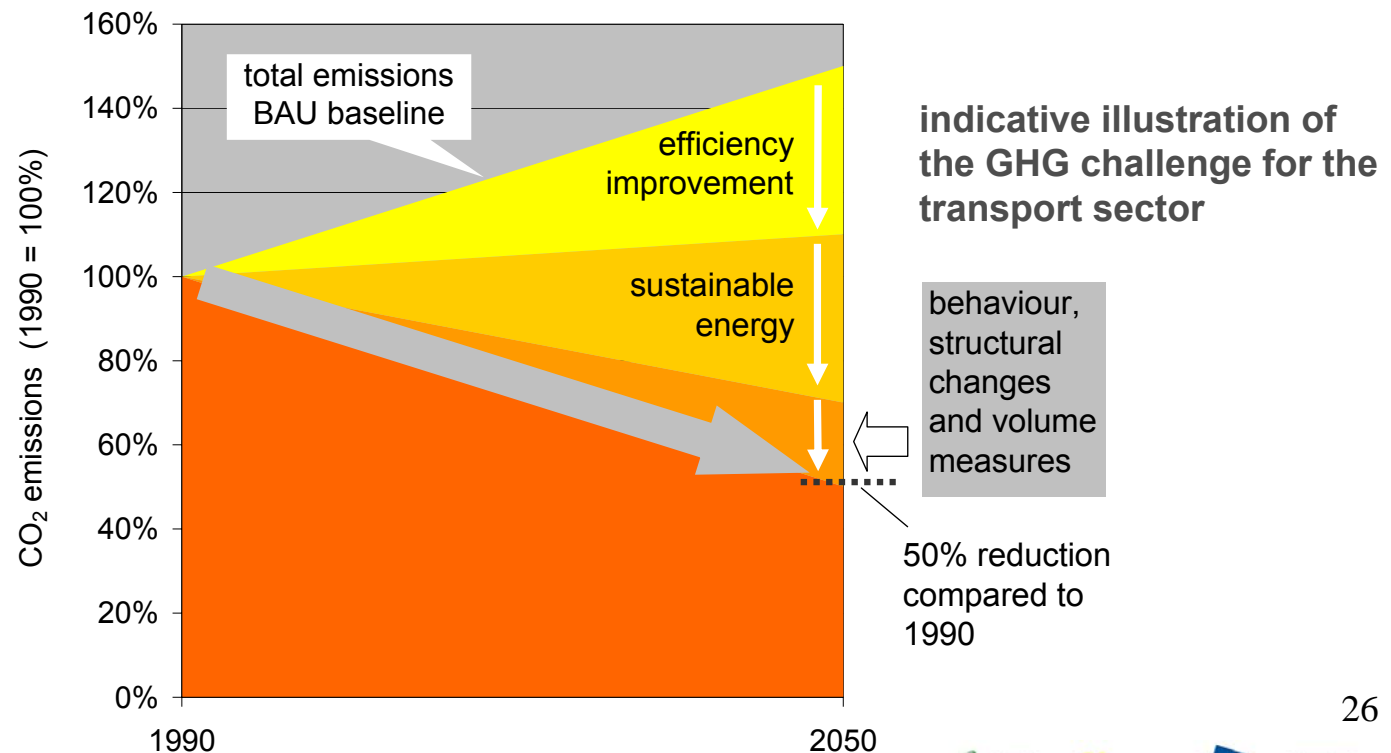
# Discussion (1)

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- Which technologies do you think *must* be part of a low carbon transport sector in 2050?
  - Will there be a dominant technology?
  - What are the large “chunks”?
    - generating the major share of required GHG reductions
  - When do these need to be introduced?
  - When do we need to make a choice?
  - What do we need to know of these options to be able to make this choice?

## Discussion (2)

- Do these technical options solve the GHG problem within transport?
  - If not, which non-technical options are important?
  - Which kind of structural changes are required?
  - Do we need to limit transport growth as part of a long-term package to reduce transport's GHG?



# Discussion (3)

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- On which key questions regarding technical and non-technical options should this project focus in particular?
  - What do policy makers need to know to be able to make the right choices?
  - What do other stakeholders need to know to be able to make the right choices?