Future options for Heavy Transport Vehicles

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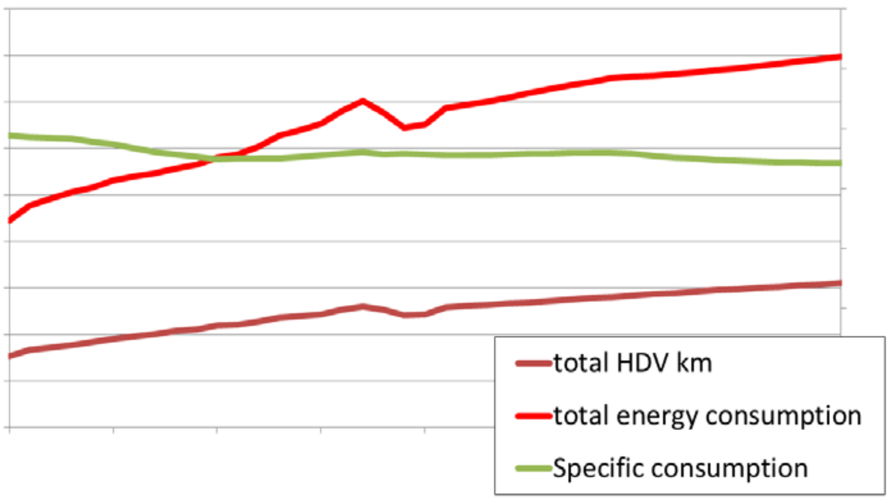

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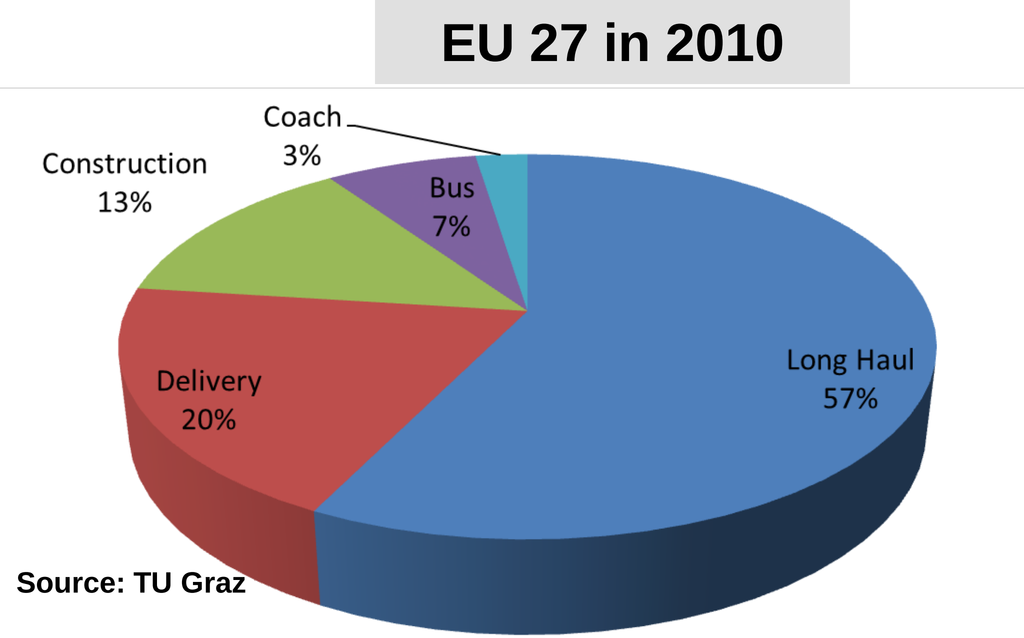
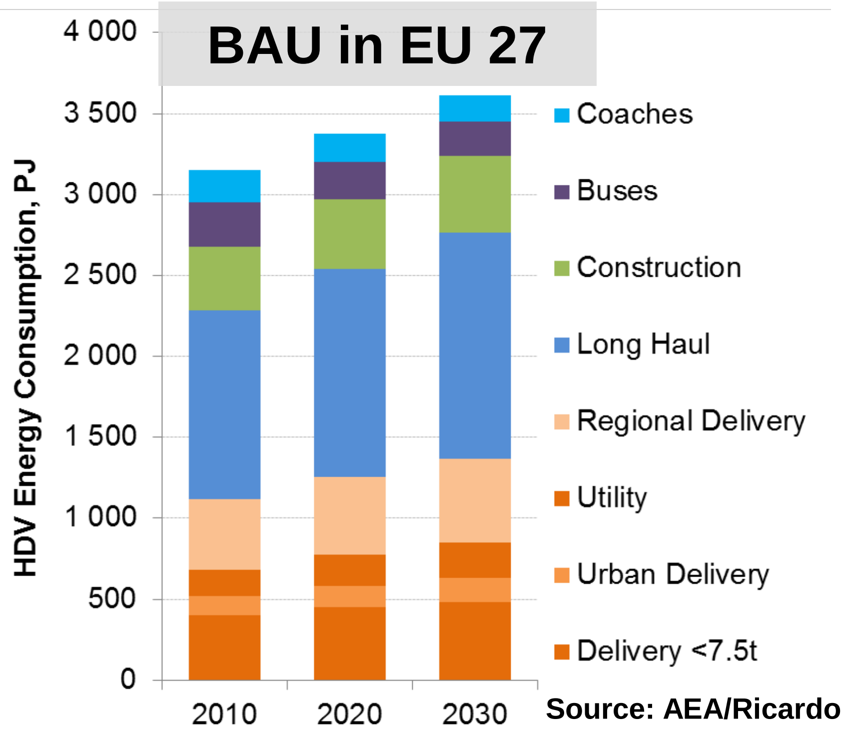
Introduction

Total transport volumes and related energy consumption from road goods transport are increasing.

Approximately 75% of the energy consumption from road freight transport are related to long haul and regional delivery in European traffic.



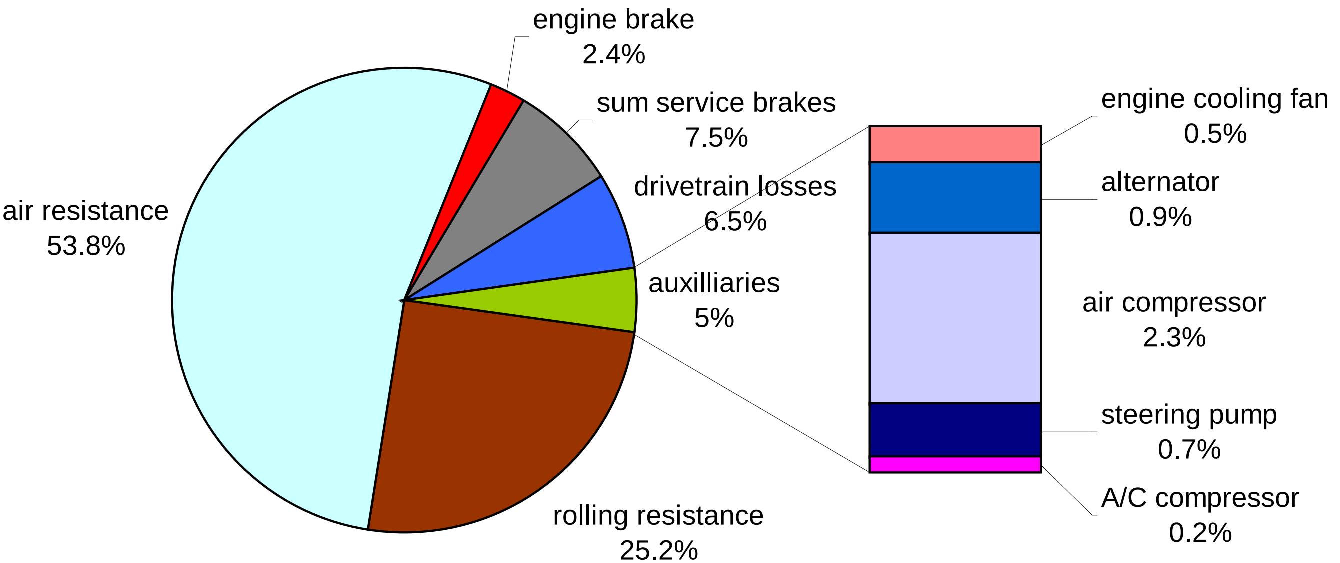
Source: TU Graz



Source: AEA/Ricardo

Further improved energy efficiency and use of alternative energy necessary to reduce consumption of crude oil and CO_2 emissions.

Shares in energy consumption of a semitrailer



Example: EURO V semitrailer with total 28 t, highway

Important components = high share in energy consumption of vehicle + vehicle with high share in total energy consumption

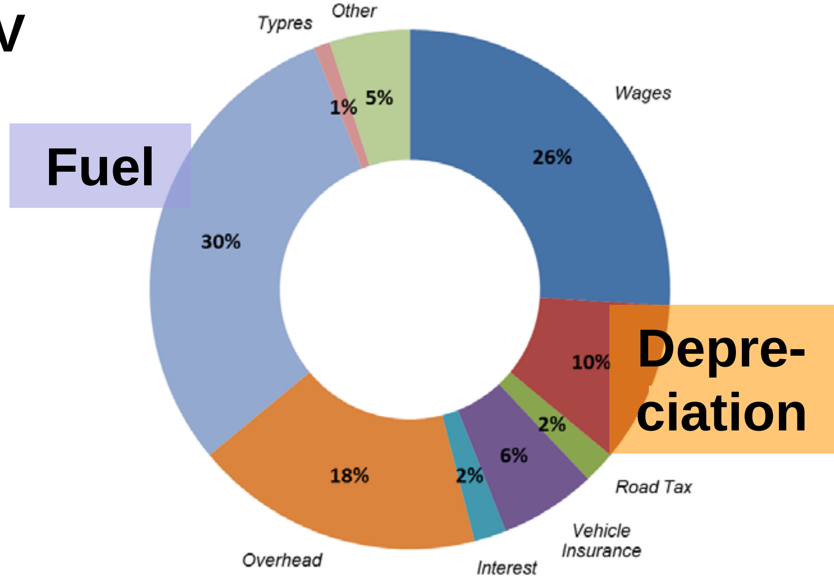
→ Design of chassis, bodies and trailers (air resistance in long haulage)
→ Rolling resistance (all vehicle classes)
→ Brake energy recuperation (all vehicle classes)
→ Drivetrain losses (all vehicle classes)
→ Auxiliaries (buses, coaches, construction, others)
→ Efficiency of propulsion system (all vehicle classes)

Potential

Influence of vehicle components depends very much on the mission profile of a HDV

10% Improvement of:	Long haul	City bus
Air resistance	-3.5%	-0.4%
Rolling resistance	-3.5%	-1.2%
Auxiliaries	-0.4%	-4%
Propulsion system	-10%	-10%

Cost brake down 40t semitrailer (source AEA/Riacrdo LOT1)



Technologies exist, main barriers are:

- **Energy efficiency of vehicle / body / trailer combination not documented in official test procedures**
  → create realistic test procedure for entire vehicle (g/km or g/ton-km)
  → make a HDV CO2/fuel consumption label
- **Payback period of technologies has to be short (~2 years) in this sector**
  → increase fuel prices
  → set limit values for vehicle CO2-emissions,
  → ……

Test procedure under development in EU

(Japan, US and China have already introduced a HDV CO2 test)

Status EU DG CLIMA January 2012:

Possible new policy actions aiming at reducing HDV CO_2 emissions

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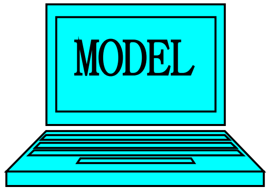
- CO_2 Measurement + reporting tool
- HDV Labelling
- Establishment of emission reduction objectives
- Economic instruments
- Design/ performance requirements for components
- Measures targeted at HDV purchase and use

EUROPEAN COMMISSION

Climate Action

TU Graz co-ordinates development of test procedure

Overview test procedure for Heavy Duty vehicles



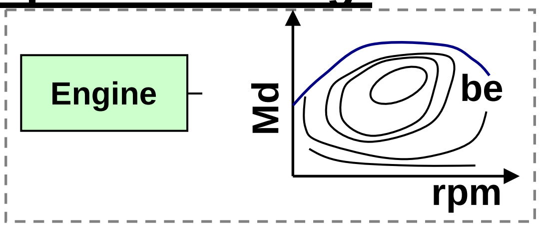
$Pe = P_{roll.} + P_{air} + P_{acc} + P_{grad} + P_{tr.} + P_{aux} + P_{cons.}$

$n = (v \times 60 \times I_{axis} \times I_{gear}) / (d \times \pi)$

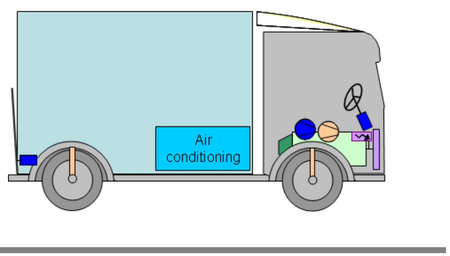
Driver model

Fuel cons., CO_2

Component testing:

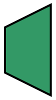


Fuel consumption map:
a) steady state + WHTC correction factors
measured on engine test bed (for engine families)



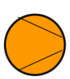
Driving resistances, options:
a) constant speed with torque measurement
b) coast down tests

Influence from different tire models: resistance values adapted to EC No 1222/2009 (absolute value, optional with correction factor from drum to road)



Gear box, axis:
transmission, η=F(…)

Transmission ratios, transmission losses
OEM specific maps and default values

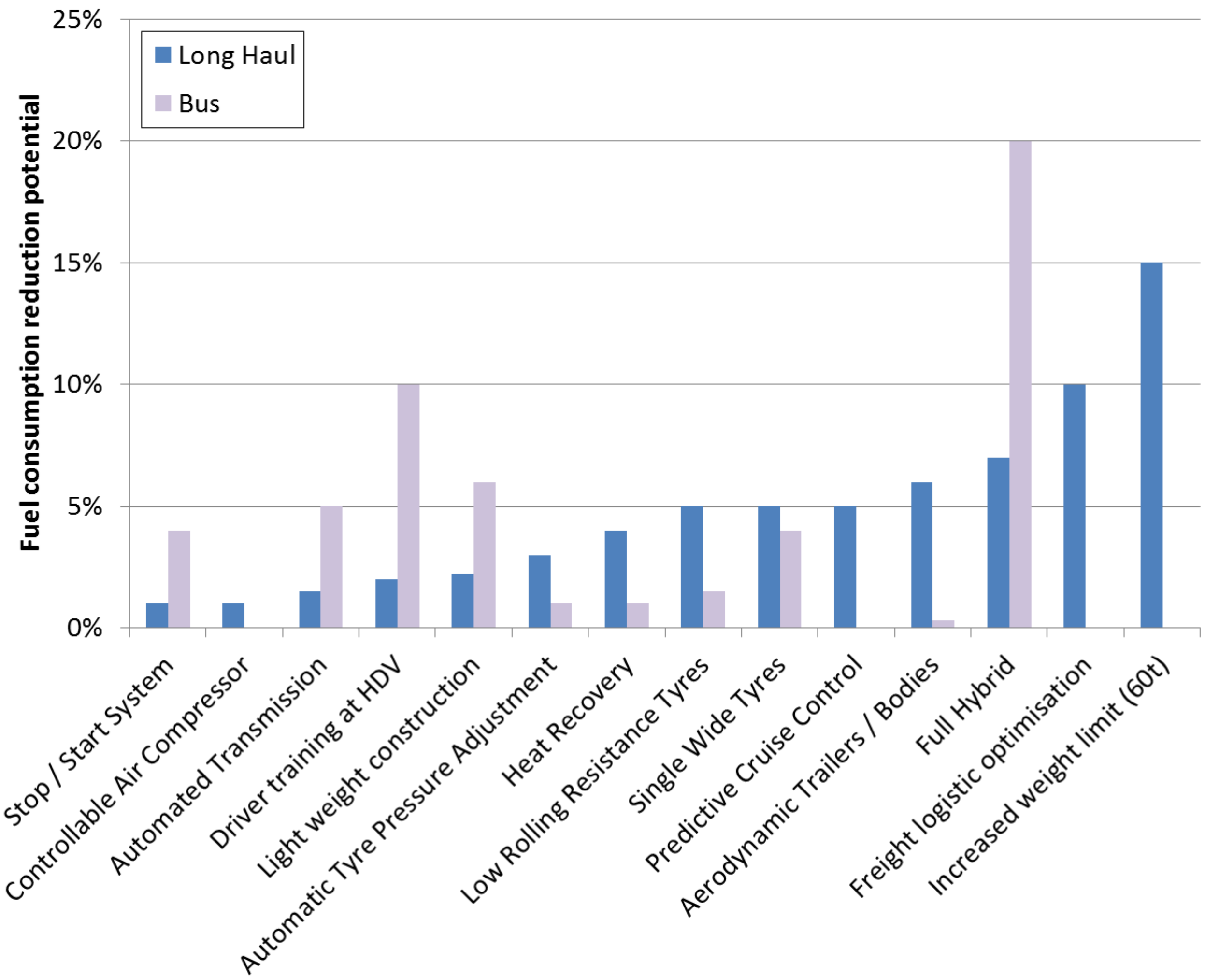


Auxiliaries
duty cycle, η=F(…)

Power demand from engine from
a) generic P_e for different technologies
b) detailed simulation

Energy reduction potential for HDV

Some technologies already implemented in several models.
Potential depends on mission profile of the HDV.

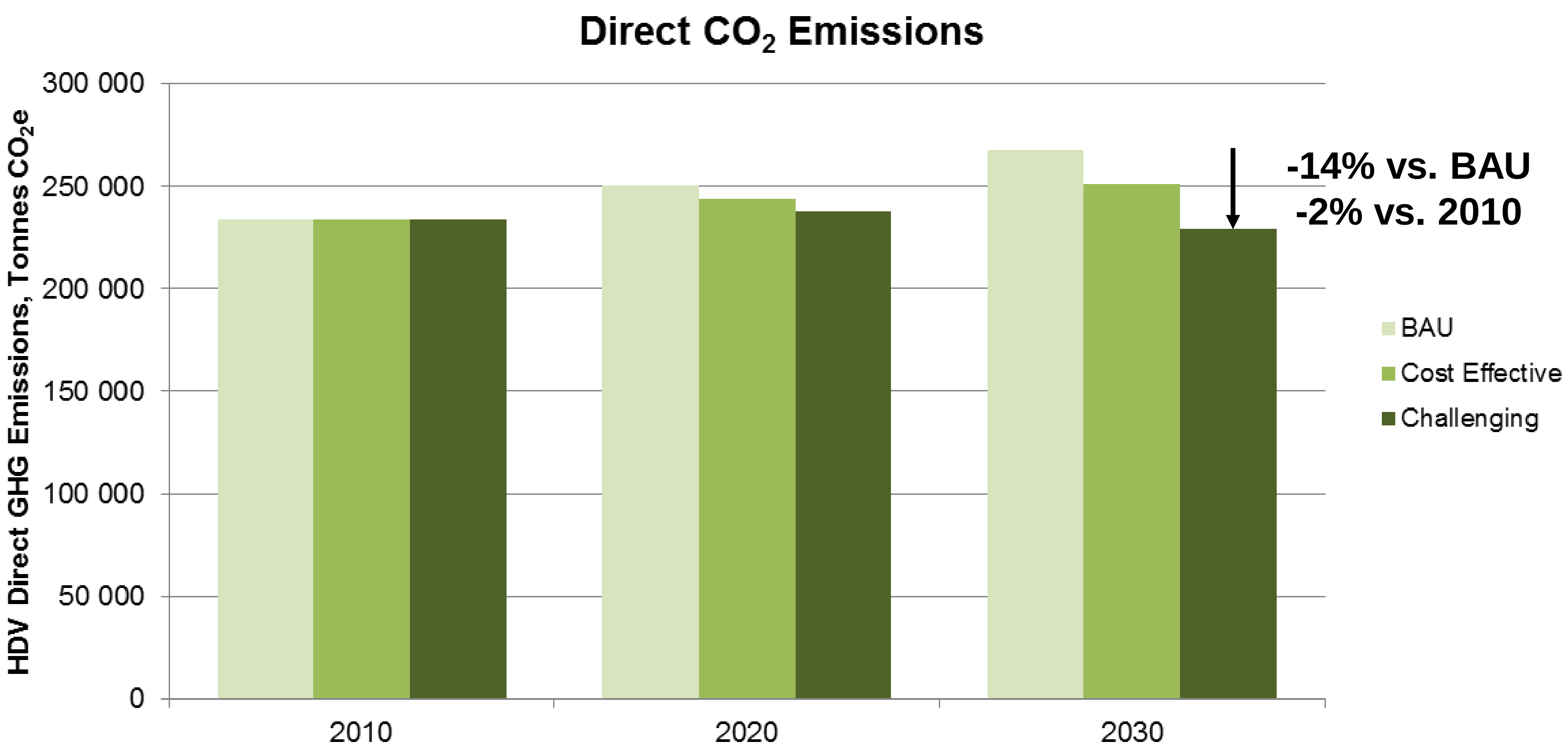


Total potential may be approx.:
-30%
without radical changes in legislation and design.

Cost efficient potential is much lower
approx. -10%

Long term perspective

Technological potential to improve energy efficiency of HDV is not sufficient to reduce CO2 emissions from HDV sector; e.g. EU 27:



source AEA/Riacrdo; LOT1

Long term perspective

Additional measures:

- Reduce transport demand: difficult
- Shift to less energy intensive modes (rail, water): difficult
- Shift to renewable energy sources: which?

Electric energy:

E-1: Batteries not realistic for HDV if > 8h service requested

650 km range
(~ 1 day driving)

WONDERCELL
100 Wh/kg
300€/kWh

→ 8 ton battery for 230 000 €

Long term perspective

Electric energy:

E-2: H_2 in fuel cell or in combustion engine: very expensive

E-3: trolley truck: expensive infrastructure

Alternative fossil fuels:

Liquid HC from CH_4 or coal (GHG emissions!)

Biofuels:

FAME, bio gas in dual fuel diesel engines: limited availability

⇨ **Increasing economic growth needs also not cost effective measures if energy consumption from HDV shall be reduced**

Summary

- HDV sector has increasing ton-km and increasing vehicle mileage
- Potential for cost efficient reduction of energy consumption by technological improvements is limited
- Further increase of energy consumption is likely
- Official test procedure for HDV fuel consumption and CO_2 emissions will allow setting target values and limit values to exploit also not cost efficient technologies
- Alternative energy sources for HDV are limited or expensive if typical daily range of HDV shall be kept
- Reduction of CO_2 emissions from HDV will be very challenging


EU Norm
Engine
be
Md
rpm
g/km, g/t-km, g/m³-km
Thank you for your attention!