



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



EU Transport GHG: Routes to 2050?

Technical options for heavy duty vehicles

Tom Hazeldine (AEA)

Ruben Sharpe (TNO)

Session 1a July 3, Brussels

Partners

www.eutransportghg2050.eu

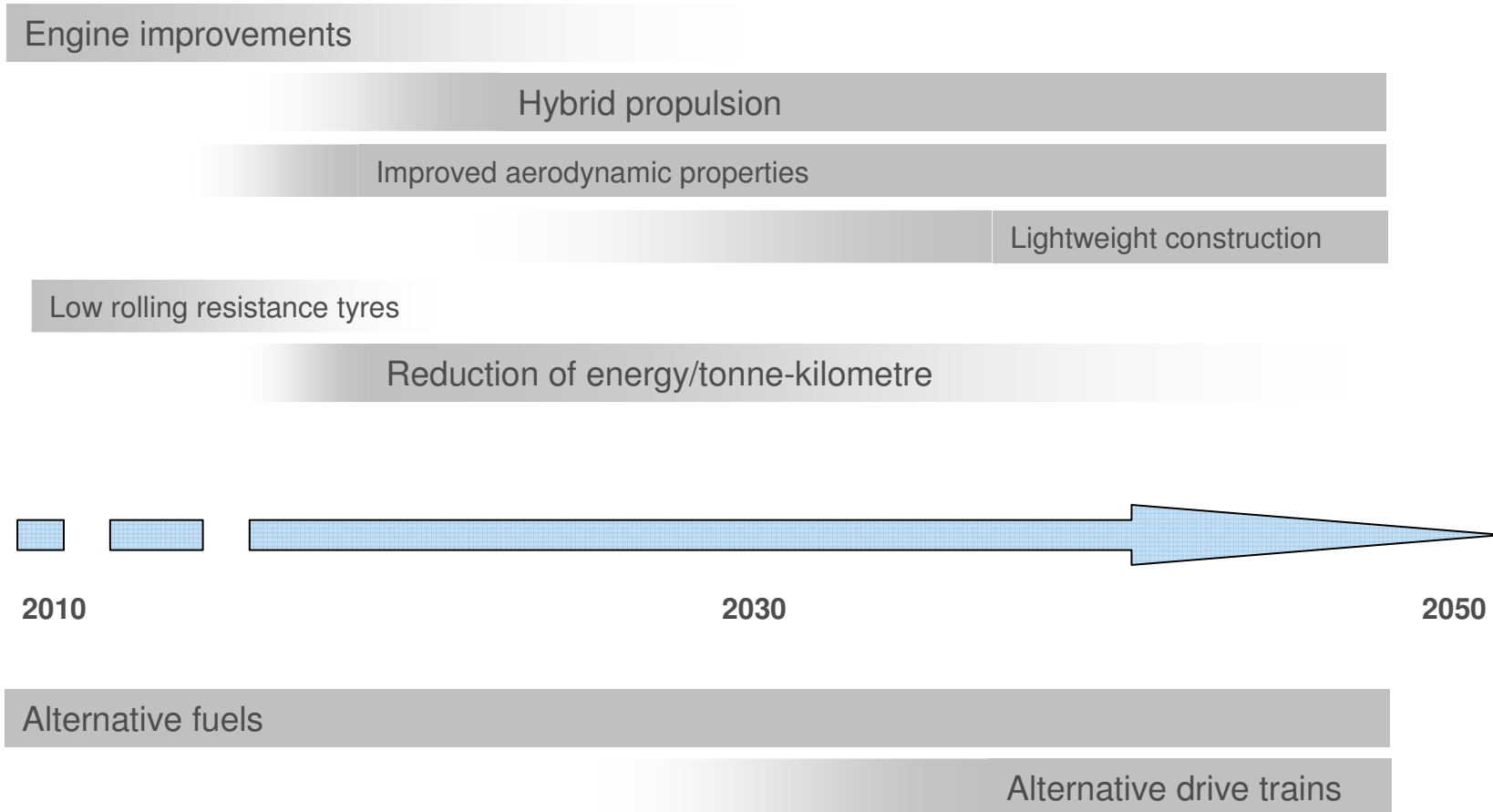


Options overview

- Engine improvements (~5%)
- Hybrid propulsion (~15%)
 - Most efficient for buses and distribution trucks
- Alternative fuels/drive trains
- Reduction of energy requirements per vehicle
 - Low rolling resistance tyres (~6%)
 - Improved aerodynamic properties (~6%)
 - Truck/trailer shape (legal requirements)
 - Most efficient for long haul transport
 - Lightweight construction (~7%)
 - Lightweight design/lightweight materials
 - Buses and distribution trucks
 - Weight of the vehicle versus the weight of the load
 - Role of inertia w.r.t. vehicle dynamics
 - Long haul
 - Reduction of CO2 per tonne-kilometer
- Reduction of energy requirements per tonne-kilometre (~9-20%)
 - Increasing the weight limit (e.g. to 44 or 60 tonne)
 - Elongation
 - (road trains?)

Options overview

???



Considerations for HD

- The reduction potential for HD is limited by:
 - HD vehicles are already designed with fuel efficiency in mind
 - HD vehicles have relatively low power to weight ratio
 - Trailers have a long service life (~20 yrs)
 - Slow penetration of new technology
 - *In the short term*, emission legislation (Euro VI) somewhat counteracts the CO₂ reduction potential
- Elongation and an increased weight limit require legislative changes
 - Capacity increasing options reduce the cost of transport
 - Consequential increases in transport counteract environmental gains
- Specification
 - Hybridization/aerodynamics
 - Weight reduction because of lower requirements for structural strength
 - Segmentation of legislative issues?

HGVs – Alternative energy carriers

- Electric traction
 - Potentially the least carbon intensive option
 - Smith Electric Vehicles have developed a 12tonne EV truck (price is £74k to £80k)
 - In the medium term applicability is limited to HGVs travelling modest distances due to:
 - Requirement for a large, expensive battery pack
 - Limited range
 - Lack of widespread charging infrastructure
- Hybrid traction
 - Greater medium term potential for hybrid HGVs than electric HGVs
 - Fuel savings from regenerative braking and stop-start functions (up to 20% in urban areas, Infrac 2007)
 - Much smaller (and hence cheaper) batteries than a pure electric HGV
 - Volvo hybrid trucks already being trialed
 - E.g. Veolia is leasing 4 hybrid rubbish collection trucks in the UK and France
 - Marginal capital cost is 153Euro/tonne of CO2 abated, Infrac 2007

HGVs continued

- Hydrogen/fuel cells
 - Very unlikely to see commercial applications for foreseeable future
 - Cost, durability and power density are all issues with fuel cells
 - Hydrogen is less energy dense than diesel therefore lower range
 - Would require a new refuelling infrastructure
 - *Perceived* safety risk (although less flammable than gasoline and would float away if leaked)
- CNG/LNG/LPG
 - NG engines are 5% to 25% less fuel efficient than diesel (INFRAS, 2007) but NG is less carbon intensive so GHG emissions are similar
 - Strong air quality benefits
 - Already NG trucks on the road e.g. UPS has 800 worldwide
 - NG HGVs are typically more expensive to purchase (~25%) but cheaper to run
 - NG is less energy dense than diesel so NG HGVs have a lower range
 - Lack of widespread refuelling infrastructure is a barrier
 - Dual fuelling has more potential
 - It can still run as a diesel truck, which negates infrastructure issue
 - Manufacturer claims it reduces operating cost by up to £24,000 assuming 200,000km
 - Manufacturer claims CO₂ emissions reduced by 20% per year based on 90% diesel substitution
 - Existing vehicles can be retrofitted

HGVs continued

- Biofuels
 - 10% blend will be mandated by EU Renewable Energy Directive by 2020
 - Concern regarding the impact a higher percentage would have on engines
 - Potentially, very significant GHG reductions
 - 38% to 64% GHG savings for biodiesel from oilseed rape
 - Significantly more expensive than conventional diesel
 - Sustainability issues
 - First generation biofuels use food crops
 - Emissions savings are country-specific
 - Direct and Indirect Land Use Change can increase emissions elsewhere
 - Increased fuel consumption
 - Decreased power

Buses – Alternative energy carriers

- Electric traction
 - Battery cost is a key barrier
 - According to Transport for London, not currently able to meet operational requirements (18 hours per day),
 - Recharging is less of an issue since most buses are captive fleets so only require one set of infrastructure
 - A long term option once battery technology improves
- Hybrid traction
 - Well suited to the stop-start bus drive cycle
 - Many hybrid buses already in service (e.g. 60 in London, Vienna) but not yet mass production
 - 40% price premium (Volvo)
 - 20% – 30% reduction in fuel consumption and hence GHG emissions (Volvo)
 - Payback of 4 to 7 years

Buses continued

- Hydrogen/fuel cells
 - Hydrogen fuel cell buses already trialled in Europe during 3 year CUTE project ending in December 2005
 - Buses operationally available 90% of the time
 - Transport authorities are purchasing hydrogen buses in small numbers
 - Transport for London plan to buy 10
 - AC Transit in US is buying 12 for \$28million (i.e. \$2.33million per bus vs ~\$350k to \$400k for a diesel bus)
 - The marginal capital cost means they will be a long term option
 - *Perceived* safety risk
- CNG/LNG/LPG
 - Similar GHG emissions to diesel
 - Buses are more expensive to purchase (~25%)
 - But cheaper to run
 - Lower range than diesel bus
 - Lack of widespread refuelling infrastructure is a barrier

Buses continued

- Biofuels/Biogas
 - Biofuels
 - Similar pros and cons to HGVs
 - Biogas
 - Can be produced from various sources
 - Landfill sites, human waste, kitchen waste etc
 - For example, Oslo will be running 80 buses on bio-methane captured from a sewage plant
 - Schemes to make use of biogas will tend to make use of local waste 'resources'
 - Synergies between efforts to reduce waste and climate change goals
 - GHG reductions
 - ~44 tonnes per bus at the Oslo project taking account of electricity usage at the sewage plant
 - Reduced fuel costs
 - Price for Oslo biogas is around 0.27 Euro per litre vs 0.67 Euro per litre for diesel (Jan 2009)
 - NG buses are more expensive