

REDUCING CO₂ EMISSIONS OF ROAD FREIGHT TRANSPORT

An integrated approach to road freight transport CO₂ reduction in Europe – a consolidation of collective knowledge

Tim Breemersch – Kris Vanherle



Outline

- About us
- Study context - methodology
- Results: Vehicle-related measures
- Results: other measures (operational, infrastructure)
- Conclusions

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Transport & Mobility Leuven

- University spin-off (+/- 20 employees).
- We predict the impact of transport policies.
- We base ourselves on state-of-the-art theoretical findings and on extensive practical knowledge.
- Multidisciplinary Team:
 - Civil Engineers, Computer Scientist, Psychologist
 - Economists
 - Environmentalists
- Based in Leuven – Belgium (30km E from Brussels)

Transport & Mobility Leuven

Research in Transport & Mobility Leuven:

- Quantitative & Ex-Ante
- Our topics: traffic management, urban mobility, sustainable mobility policy, emissions, traffic safety, freight transport, rail, shipping, transport economics, spatial and social economics
- Our tools: TREMOVE, EMMOSS, CAR, WCM, NODUS, EDIP, TIGER, RHOMOLO, SUSTRUS, Fleet prediction tool, CBA, data enrichment

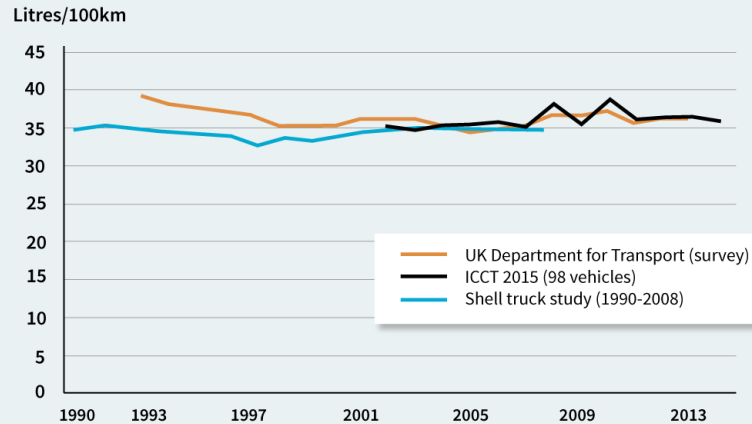
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Context (1)

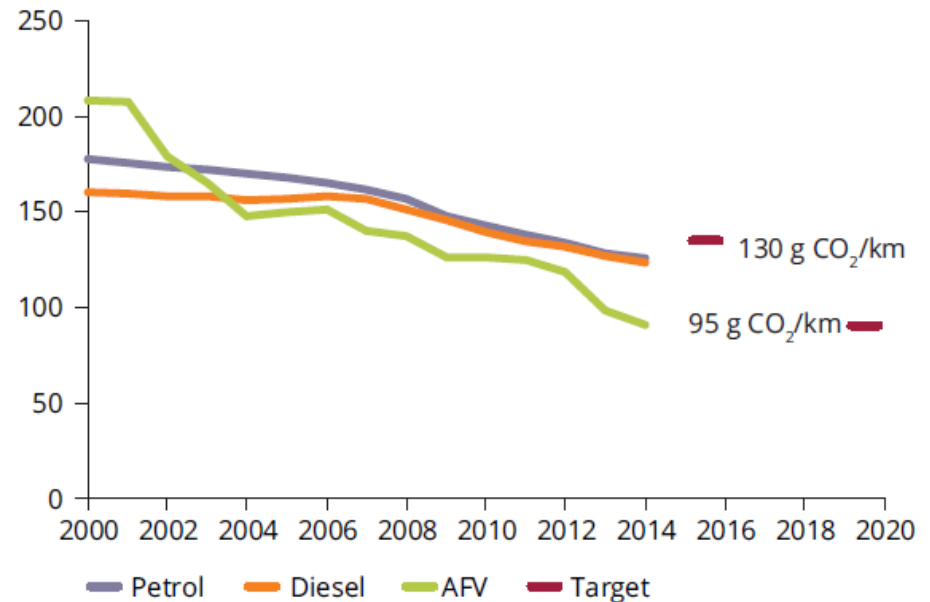
- Strong legislation in EU on CO₂-emissions of passenger cars, less so on HDV

20 years of progress? Truck fuel consumption since the 1990s



TRUCKS

CO₂ emissions (g CO₂/Km)



CARS

Context (2)

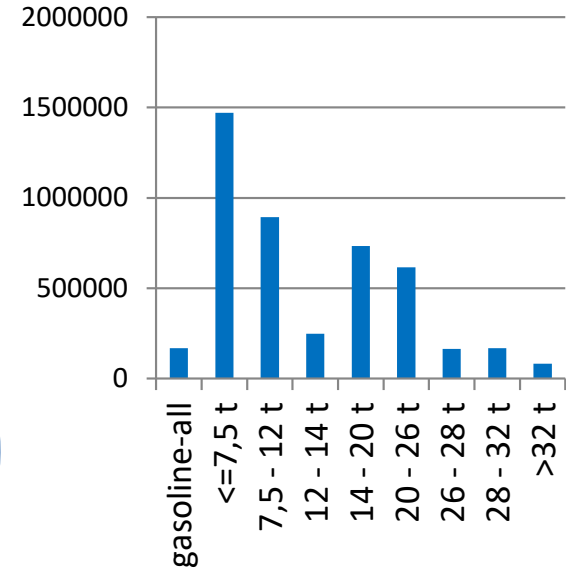
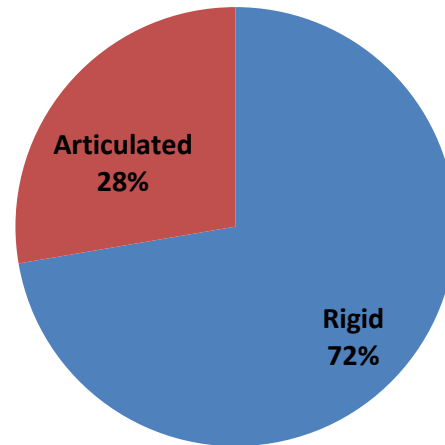
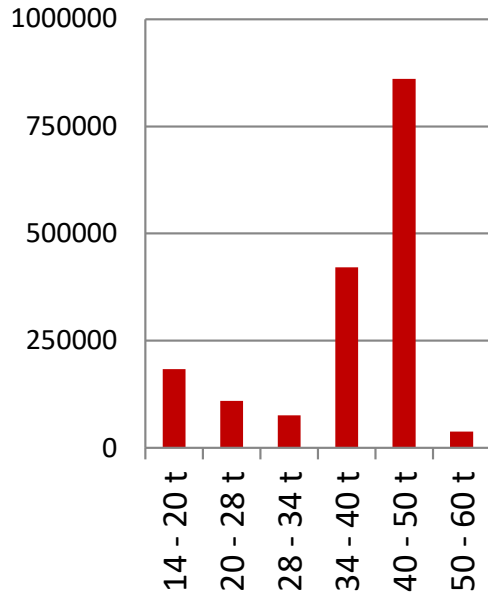
- Further reduction potential “drying out” and traditional EU leadership role in jeopardy, focus is now shifting to HDV → legislation in development
- ACEA (manufacturers association) pro-active exploring reduction potential in road freight CO2 emissions → TML contracted as independent research institute to explore reduction potential in 2020
- “integrated approach”: OEM, suppliers, operations, infrastructure,...

Methodology (1)

- Extensive literature review, meta-analysis of technology reviews
- Supported with stakeholder feedback (confront findings, update if needed)
- **Anonymous** survey manufacturers (via ACEA)
 - Effects of technological measures at the vehicle level (with VECTO)
 - Effects of measures not tied to the vehicle
 - Effects of combinations of vehicle measures as a full vehicle package

Methodology (2)

- Reference vehicles for long haul (LH) and regional delivery (RD) details → see paper
- Considering “stackability” of measures (interaction effects)
- Considering EU fleet composition and fleet turn-over dynamics



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Vehicle-related measures (1)

- Conventional engine efficiency
 - Expected to be the dominant engine technology for some time
 - Various improvements: turbocompounds, combustion improvement, thermal management, engine friction and aftertreatment systems

→ *4.5% RD & 5% LH by 2020*

Vehicle-related measures (2)

- Auxiliary systems
 - small share of total fuel consumption but relatively large reduction potential
 - Replacing mechanical systems by electric systems for additional power supply

→ *1.7% RD & 1.5% LH by 2020*

Vehicle-related measures (3)

- Transmission & driver assistance
 - Mechanical
 - Better timing of gear shift (considering inclination, road condition, traffic)
- 0.5% (*transmission*) & 2.5% (*assistance*) by 2020

Interaction effects with driver training (“stackability”)

Vehicle-related measures (4)

- Axles: reducing friction
→ *0.5% by 2020*
- Tyres: low rolling resistance, dimensions (wider), tyre pressure monitoring
→ *3% RD & 4% LH by 2020 (assuming 80-100% penetration rate)*

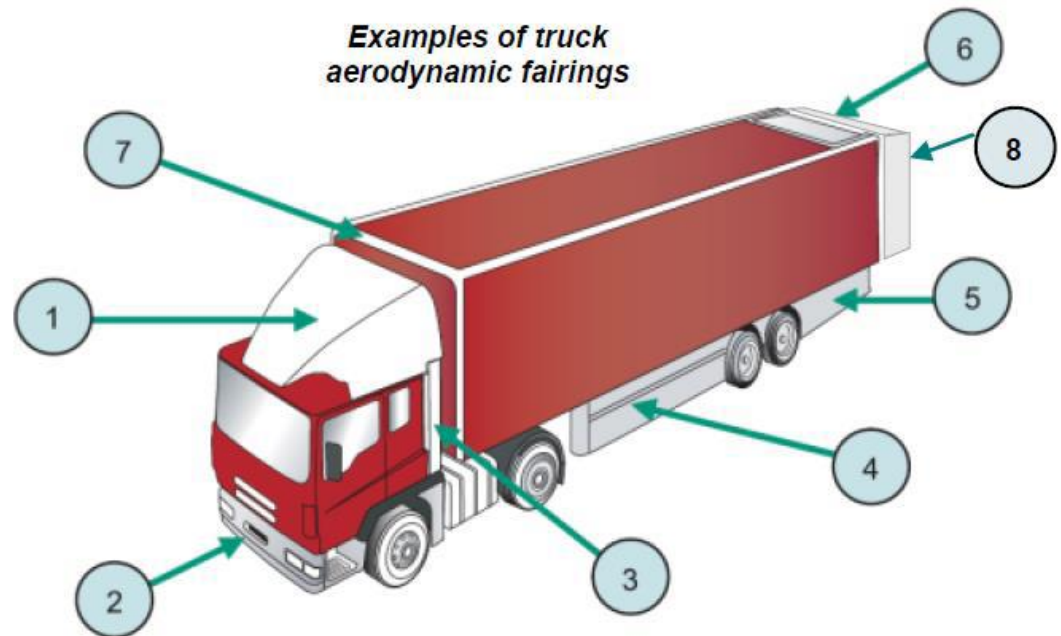
Vehicle-related measures (5)

- Aerodynamics:

- Legislation update **Directive 96/53/EC “weights & dimensions”**

- Streamlining:

- ① Cab Deflector / Fairing
- ② Air Dam
- ③ Cab Collar
- ④ Side Skirt
- ⑤ Rear Quarter Panel
- ⑥ Tapered Roof
- ⑦ Trailer Front Fairing
- ⑧ Boat-tail plates/extendors



→ 3% RD & 4% LH by 2020

Vehicle-related measures (6)

- Weight reduction:
 - Steel → aluminum
 - Rule of thumb: 1.1% fuel saved per tonne weight reduction
 - Literature: 0.6t (conservative) up to 2.2t (maximum) potential, both in chassis and trailer/body

→ 0.9% RD & 0.5% LH by 2020

Vehicle-related measures (7)

- In summary:

	Long Haul	Regional delivery
Engine efficiency	5.00%	4.50%
Auxiliaries management	1.50%	1.70%
Transmission	0.50%	0.50%
Alternative powertrains*	N/A	N/A
Axles	0.50%	0.50%
Driver assistance systems	2.50%	2.50%
Total OEM	-9.67%	-9.38%
Tyres	4.00%	3.00%
Aerodynamics: fairings, tails, etc.	4.00%	3.00%
Weight reduction	0.50%	0.90%
Total others	-8.30%	-6.76%

Vehicle-related measures (8)

Don't forget fleet turn-over dynamics!

- Data suggests 6.8% HDV replaced yearly → it takes **15 years** for new vehicle technologies to have full effect!
- However, more intense use in first years, and more so in long haul; “non-linear” vehicle life-cycle.
- Considering timing of introduction of various measures → vehicle measures impacts only reduced to **+/- 5% total potential** in 2020

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Other measures (1)

- Fuels:
 - Gaseous fuels: Compressed Natural Gas (CNG), Compressed biomethane, LPG: marginal share from trucks, not expected to increase significantly up to 2020
 - Biofuels: cornerstone of EU Renewable energy directive
 - Blend rate up to 10% in 2020
 - GHG-savings for biofuels types to be used in 2020 of 35%
 - First generation fuels (dominant in 2020) mostly on gasoline fuel; second & third generation also in diesel

→ *0.5% by 2020*

Other measures (2)

- Driver training:
 - EU legislation governing the training requirements for professional drivers in directive 2003/59/EC
 - Expected impacts: safety, maintenance, fuel efficiency
 - Various studies available with large variance (2-20%), depending on road/traffic condition, benchmark comparison, vehicle specifications,...

→ *7% RD & 6% LH by 2020*

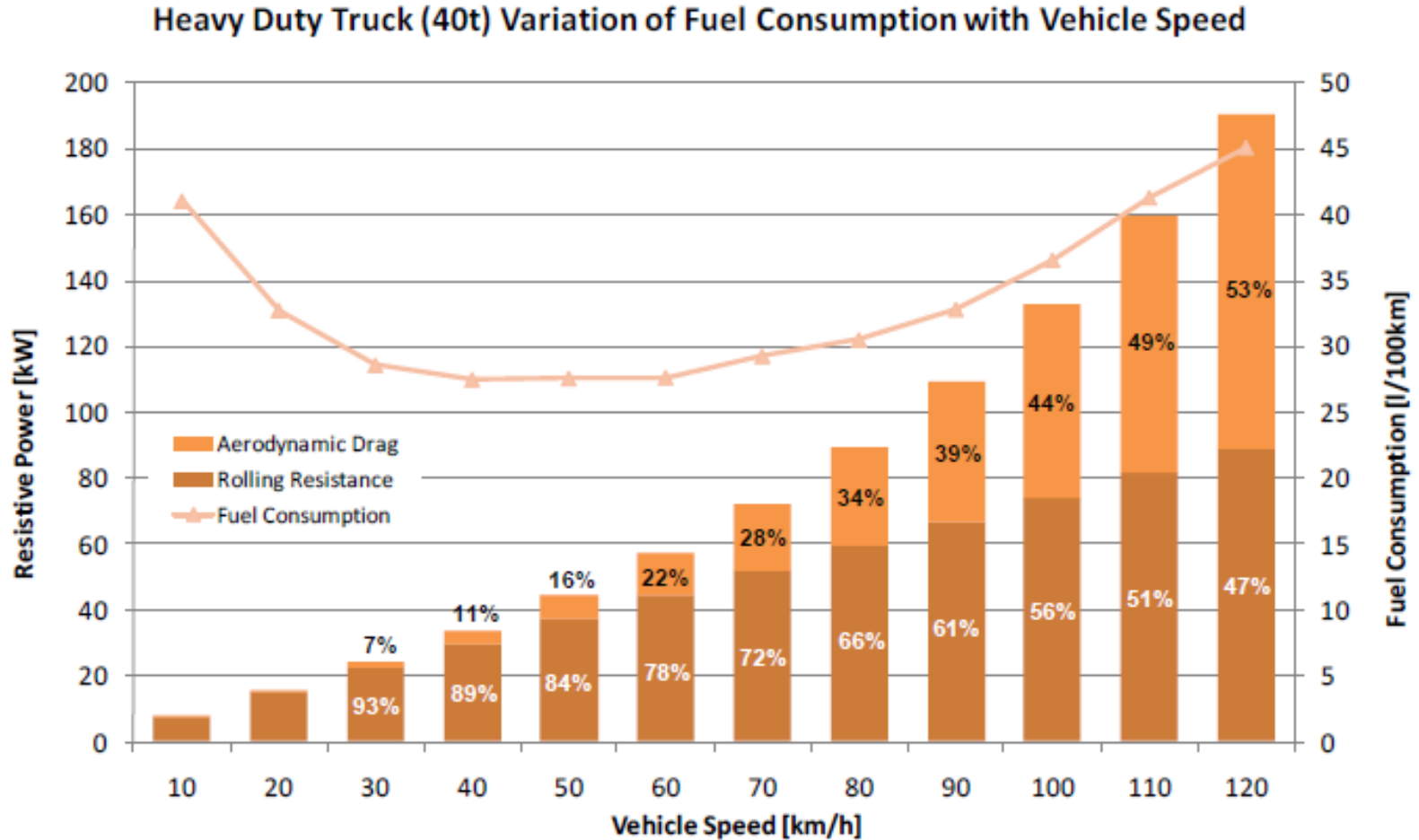
Other measures (3)

- HCT/EMS/Eco-combi's/"monstertrucks":
 - **Directive 96/53/EC "weights & dimensions"**
 - Large reduction potential → 11-12% considering EU fleet and freight demand properties
 - Extensively researched a.o. TML (2008)
 - Various "in's and out's" when estimating the overall CO2 reduction potential
 - (Conservatively) assuming 8% penetration rate of EMS, only for long haul, max 60t EMS systems

→ 2% LH by 2020

Other measures (4)

- Speed reduction:



Other measures (5)

- Speed reduction:
 - 90 → 80 km/h on motorways
 - Various studies available + tested with VECTO-tool
 - Ranges from 1%-5%
 - Important caveats:
 - Technical modification (powertrain optimization)
 - Impact on traffic flow of low-speed trucks (safety?)
 - Economic damage to be expected (offset by fuel savings?)

→ *5.98% RD & 3.82% LH by 2020*

Other measures (6)

- Cabotage & reduce empty running:
 - Cabotage: transport of goods between two points in the same country performed by a vehicle registered in another country → regulated in EU
 - Leads to avoidable empty runs
 - Difficult to single out the effect of relaxing cabotage regulation
 - Estimation: assuming a further 3% of empty runs (down from 25% in 2005 and 22% in 2012) on LH only; attributing $\frac{1}{4}$ to cabotage, correcting for lower fuel consumption of displaced empty run:.

→ 0.55% LH by 2020

Other measures (7)

- Road infrastructure:
 - Reducing rolling resistance: various studies, large variance (1-9%), depending on assumptions. Also considering the infrastructure roll-out delay-effect:

→ *1% LH by 2020*
 - Improved flow (reducing congestion): improve efficient operation of the vehicle:

→ *2% LH and RD by 2020*

Other measures (8)

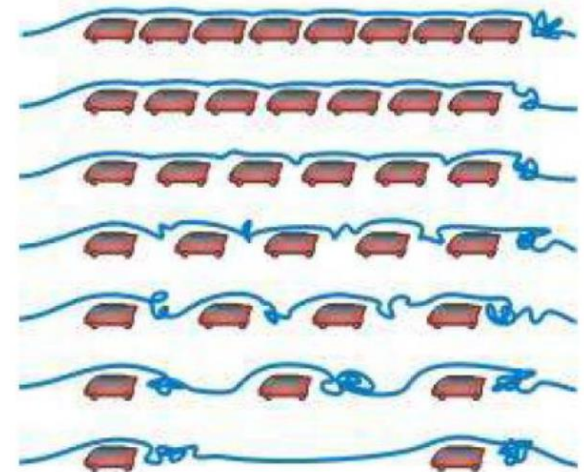
- Road infrastructure:
 - Road pricing: indirect demand effect, efficient operations, increased fuel efficiency. 1/3^e linked to fuel efficiency

Average rate per km (c€)	CO ₂ reduction
2	Close to 0
3.4-14.4	-1.7%
8	-1.95%
10-15.5 (Maut)	-3%
29	-9.23%

→ 1% LH and RD by 2020

- Platooning: expected 3-5% Improved fuel efficiency. Assuming 10% uptake by 2020

→ 0.46% LH by 2020



Other measures (9)

- Accounting for interaction effects, some examples:
 - Aerodynamics: 90 → 80 km/h speed reduction limit the benefits of improved aerodynamic design by 13%
 - Improving load factor: always an indirect effect of other policy e.g. road pricing making transport more expensive → pushing operators to (somewhat) more efficient operations
 - Driver training ↔ automation (e.g. gear shift).

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		Long haul	Regional delivery
Vehicle	OEM	-2.75%	-2.68%
	Other	-2.36%	-1.93%
Vehicle Total		<u>-5.05%</u>	<u>-4.56%</u>
Alternative fuels	Gaseous fuels	0.00%	0.00%
	Biofuel	-0.50%	-0.50%
Alternative fuels total		<u>-0.50%</u>	<u>-0.50%</u>
Vehicle operation	Driver training	-6%	-7%
	EMS	-2.00%	0%
	Speed management	-3.82%	-5.98%
	Improve load factors	No reliable estimates found	
	Cabotage	-0.55%	0%
Vehicle operation total		<u>-11.88%</u>	<u>-12.56%</u>
Road infrastructure management	Rolling resistance pavement	-1%	-1%
	Improved flow	-2%	-2%
	Platooning	-0.46%	0%
	Road pricing (HDV only)	-1%	-1%
Infrastructure total		<u>-4.39%</u>	<u>-3.95%</u>
Integrated effects		<u>-20.41%</u>	<u>-20.25%</u>

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- In theory, a 20% CO₂-emission reduction possible in 2020, compared to 2014, with constant transport demand.
- Quick wins:
 - Driver training!
 - Tyres
- High potential... with a cost:
 - Engine technology
 - Aerodynamics
 - Biofuels

Conclusions

- Difficult measures:
 - EMS...
 - ➔ could/should be a “quick win”...
 - Speed reduction: negative knock-on effects on safety, costs and logistics expected to be large
 - Road infrastructure improvements: investment cost and (very) long implementation delays

THANK YOU!

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