REDUCING CO_2 EMISSIONS OF ROAD FREIGHT TRANSPORT

An integrated approach to road freight transport CO_2 reduction in Europe – a consolidation of collective knowledge

Tim Breemersch – Kris Vanherle

TRANSPORT & MOBILITY LEUVEN

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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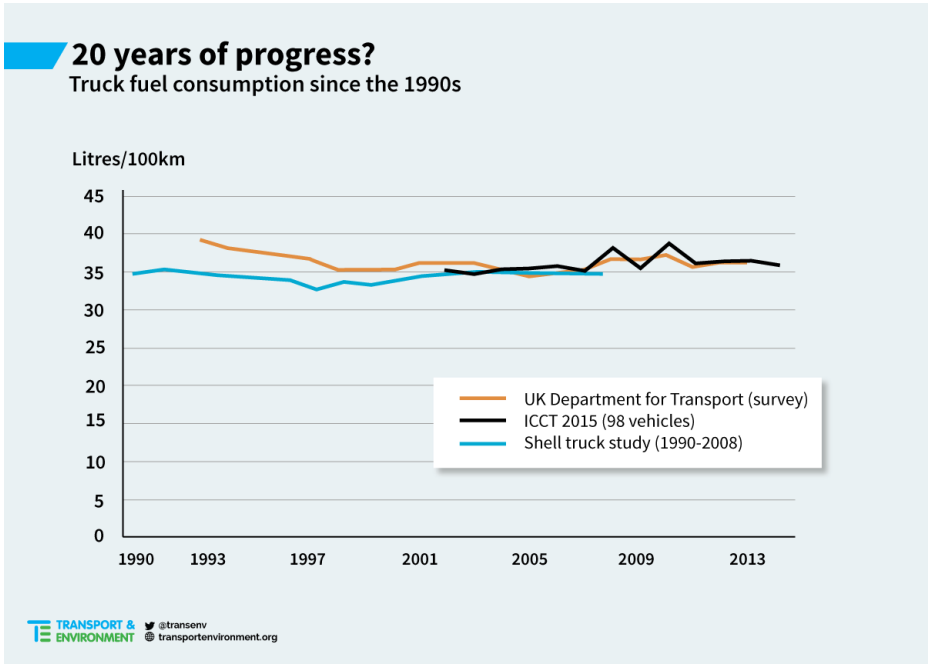
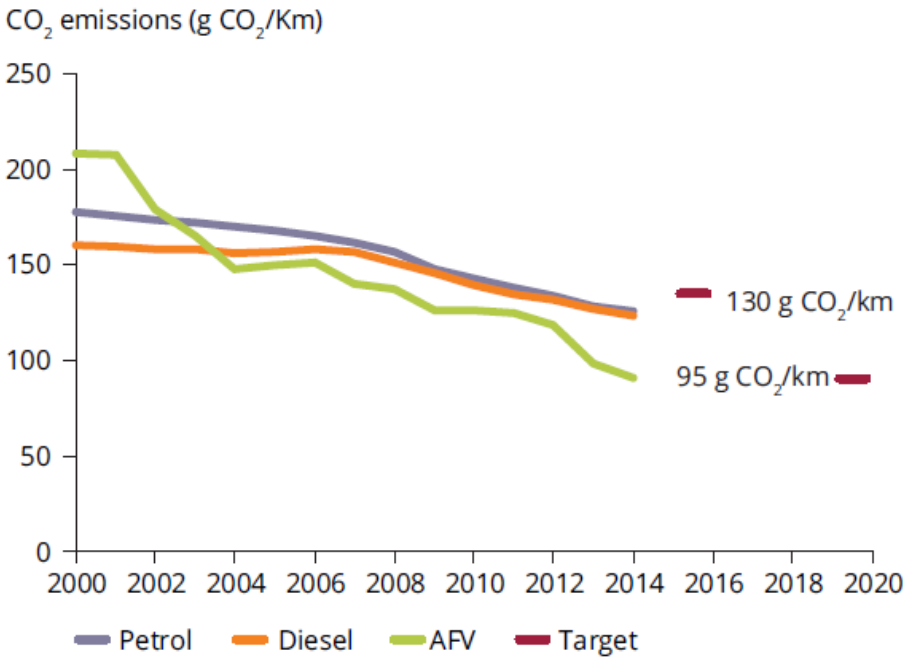
Context (1)

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



TRUCKS



CARS

Context (2)

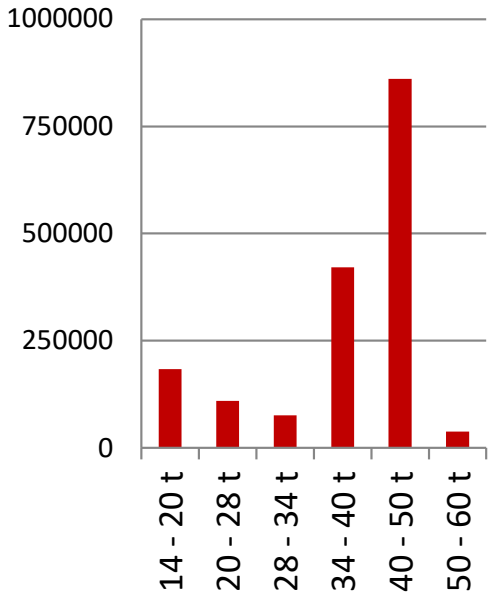
- Further reduction potential "drying out" and traditional EU leadership role in jeopardy, focus is now shifting to HDV ➔ legislation in development
- ACEA (manufacturers association) pro-active exploring reduction potential in road freight CO2 emissions ➔ TML contracted as independent research institute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

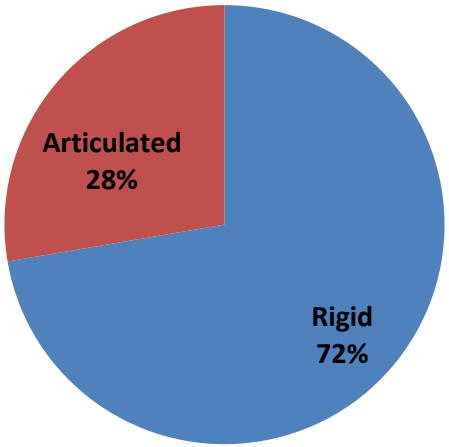
Methodology (1)

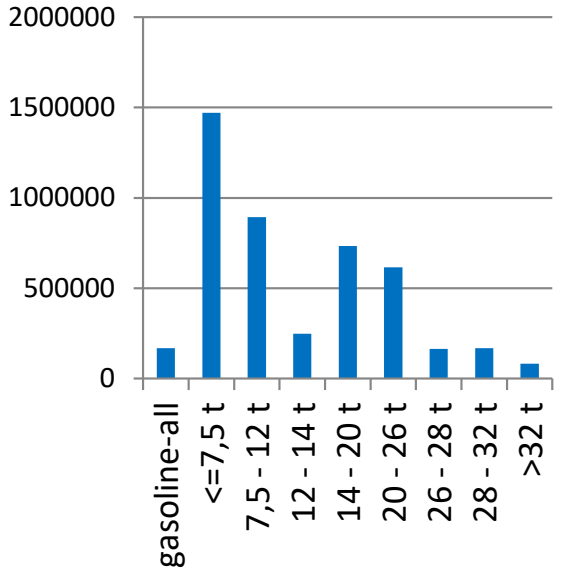
- Extensive literature review, meta-analysis of technology reviews
- Supported with stakeholder feedback (confront findings, update if needed)
- **Anonymous** survey manufacturers (via ACEA)
  - Effects of technological measures at the vehicle level (with VECTO)
  - Effects of measures not tied to the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

<u>Interaction effects with driver training ("stackability")</u>

Vehicle-related measures (4)

- Axles: reducing friction

  ➔ *0.5% by 2020*

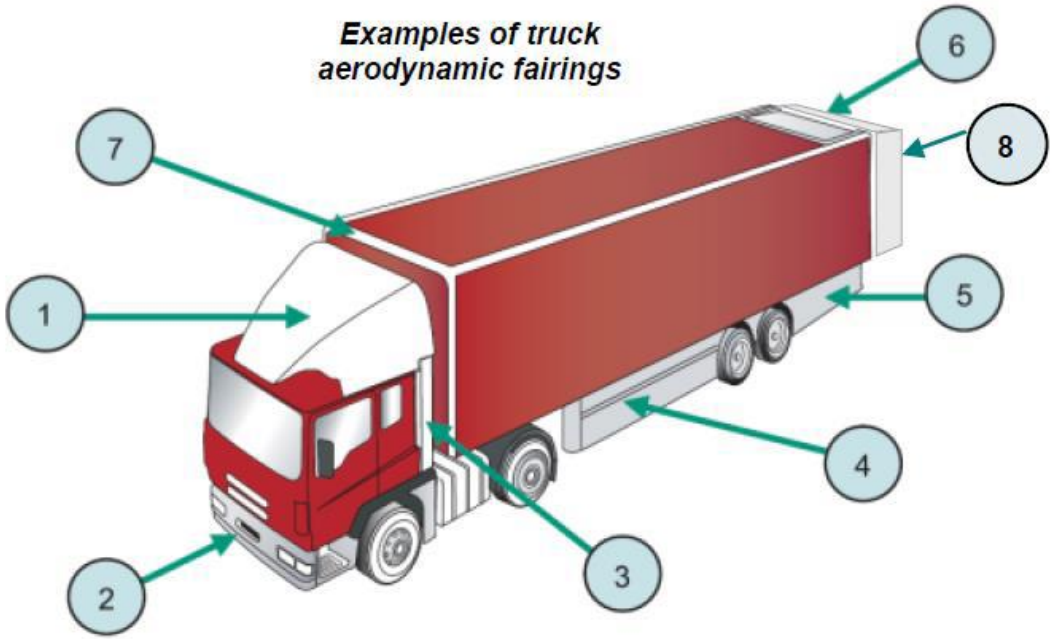
- Tyres: low rolling resistance, dimensions (wider), tyre pressure monitoring

  ➔ *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/extenders



➔*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 fro 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*

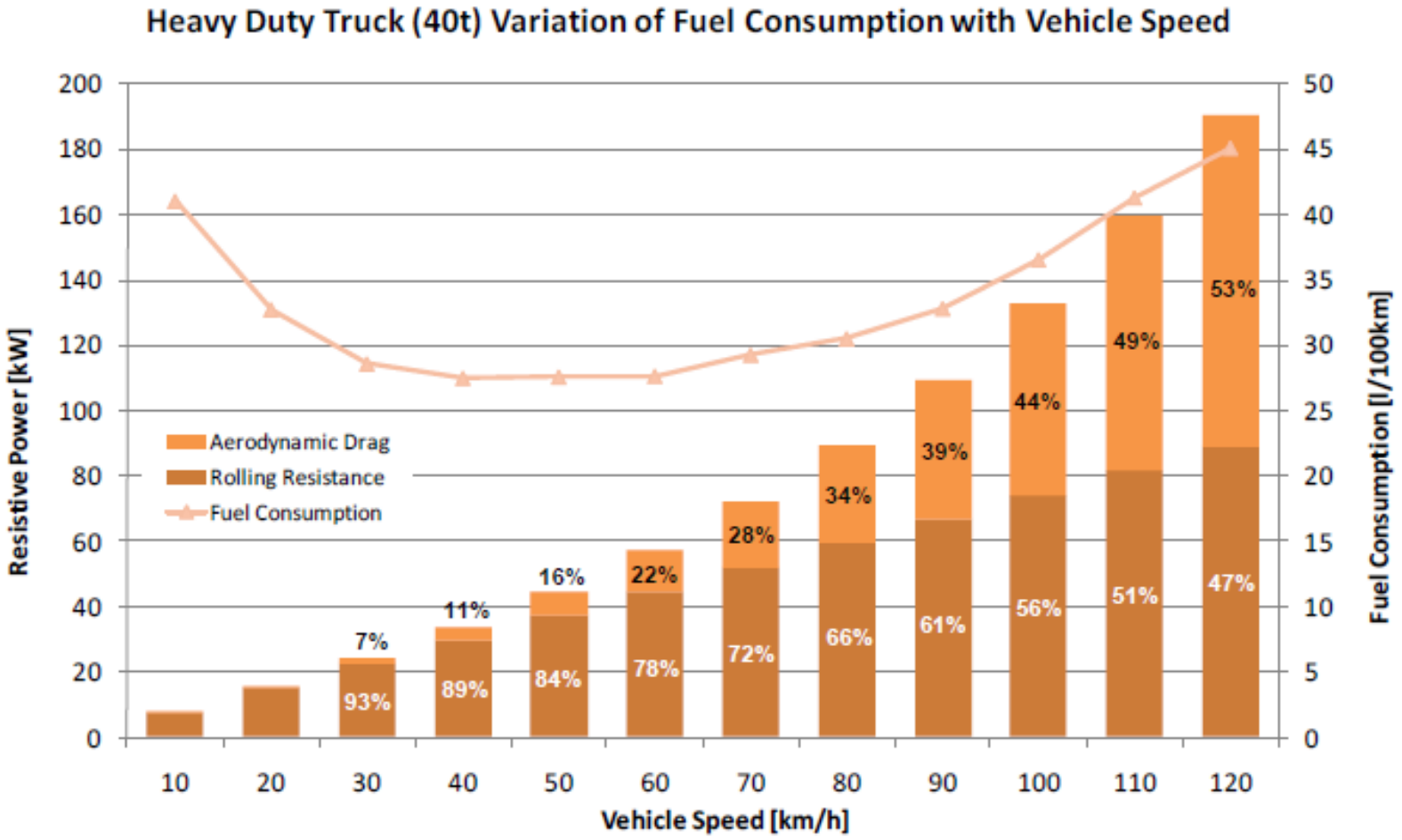
Other measures (3)

- 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 ¼ 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*

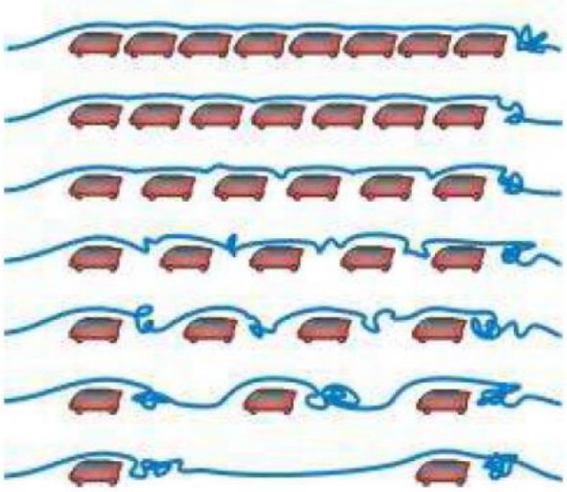
Other measures (8)

- 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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Conclusions

		Long haul	Regional delivery
Vehicle	OEM	-2.75%	-2.68%
	Other	-2.36%	-1.93%
Vehicle Total		**-5.05%**	**-4.56%**
Alternative fuels	Gaseous fuels	0.00%	0.00%
	Biofuel	-0.50%	-0.50%
Alternative fuels total		**-0.50%**	**-0.50%**
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		**-11.88%**	**-12.56%**
Road infrastructure management	Rolling resistance pavement	-1%	-1%
	Improved flow	-2%	-2%
	Platooning	-0.46%	0%
	Road pricing (HDV only)	-1%	-1%
Infrastructure total		**-4.39%**	**-3.95%**
Integrated effects		**-20.41%**	**-20.25%**

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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!

Kris.vanherle@tmleuven.be
Tim.breemersch@tmleuven.be