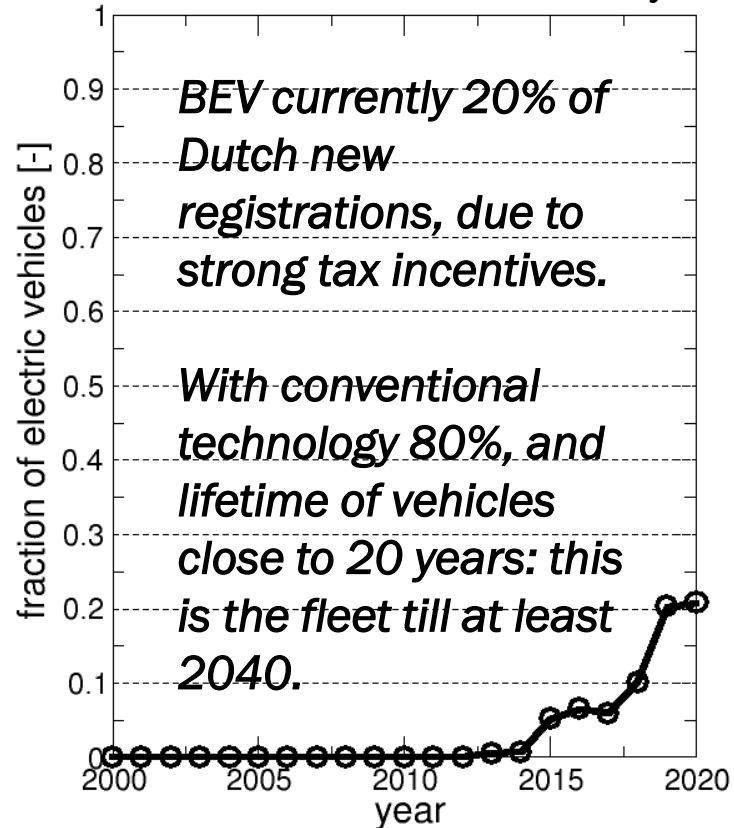


› **VEHICLE CO₂ POLICIES**
ON THE ROAD TO

› CO₂ (TANK-TO-WHEEL) EMISSION OF VEHICLES

A BROAD AND PERSISTENT PROBLEM

So ... conventional vehicles only ...



› Sketching the problem of persistence of CO₂ emissions of vehicles:

- › Different actors keeping each other in balance and thereby ineffective
- › Legislation and standards that suggests distinct responsibilities, that cannot be disentangled in reality
- › Countries cannot rely on European “tools” to meet CO₂ reduction targets
- › Mismatch of national stimulations in the free European market creating international trade
- › The wrong incentives: PHEVs, motorway speed limits, safety-by-size, etc.

› Current actions to repair the problems:

- › Gaining control with EC/2019/631 (fuel consumption monitoring and independent testing)
- › Transparency act, consumer information, Certificate of Conformity

› Paradigm shift needed

- › “Collapsing the triangle”
- › Move to the hard facts: litres of fuel, kilograms of weight,

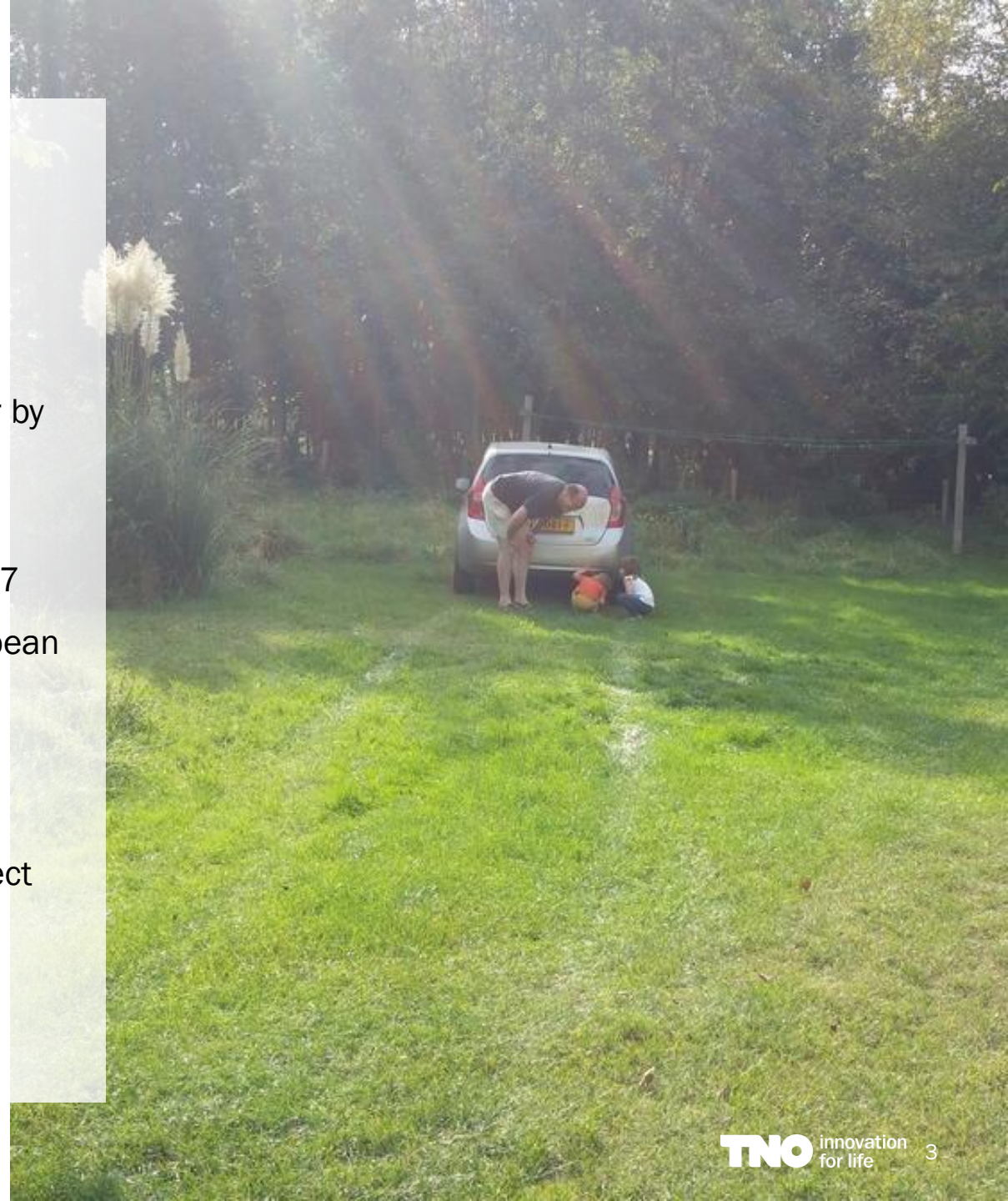
› INTRODUCING ME ...

SENIOR SCIENTIST AT TNO

Norbert E. Ligterink

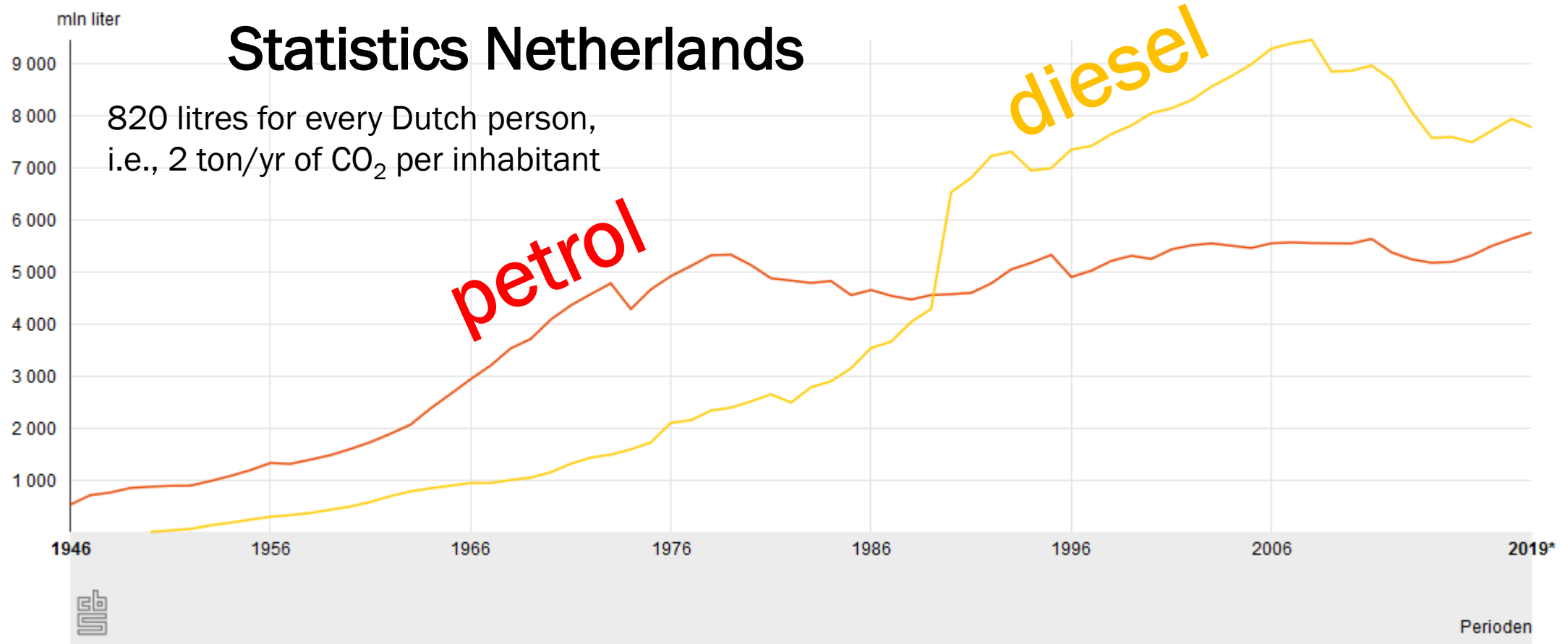
- › Theoretical nuclear physicist and mathematical system engineer by training (worked in academia in NL, UK, IT, and USA)
- › Based in the Netherlands
- › National emission factors for Dutch air quality models since 2007
- › Evaluation policies and legislation for the government and European Commission
- › Participated in the development of WLTP and RDE legislation
- › Addressing the CO₂ gap for passenger cars since 2009.
- › Developing new measurement and monitoring techniques to inject facts into policies and discussions.

See at: <https://repository.tudelft.nl/search/tno/?q=ligterink>



THE BOTTOM LINE, TALKING ABOUT TANK-TO-WHEEL ONLY

TOTAL LITRES OF FUEL CONSUMED BY ROAD TRAFFIC (~20% OF TOTAL CO₂)



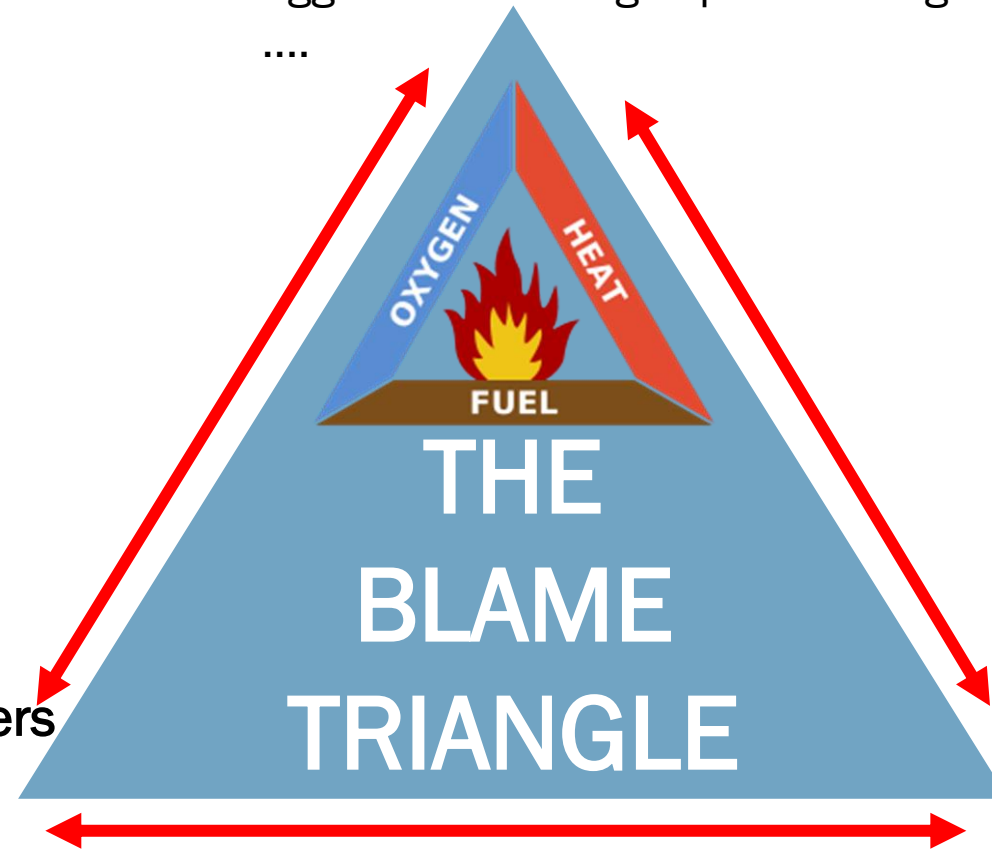
A DISPUTE WITH THREE PARTIES WILL NOT BE SETTLED UNLESS TWO PARTIES TEAM UP

Who is responsible for the high and increasing CO₂ emissions?

Vehicle owners and users
improper vehicle use
aggressive and high speed driving
....

“driving around with roofboxes”

Most research seems to shift the blame around.



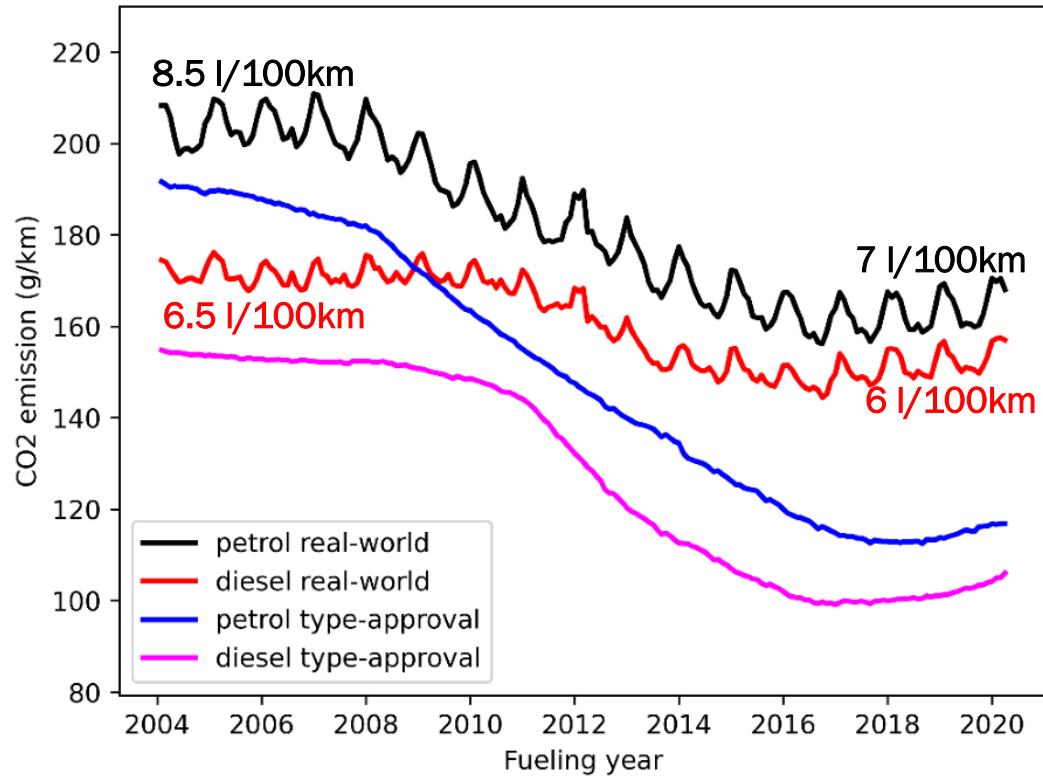
“cheating on the test”

Engine and vehicle manufacturers
Optimizing for test performance
marketing heavy and powerful cars
....

“bad NEDC test”

European Commission
faulty CO₂ emission standards
limited enforcement
....

REAL-WORLD FUEL CONSUMPTION LESS THAN HALF OF TYPE-APPROVAL REDUCTIONS

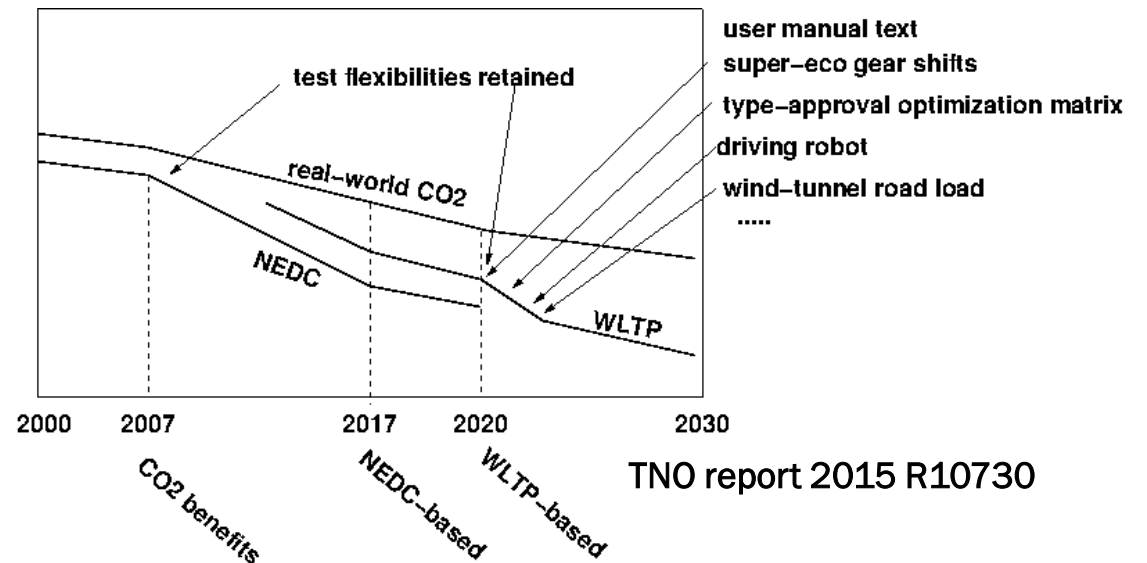


TNO report on Dutch on fueling data 2020, to be published

Already in 2009 TNO noted that lower type-approval values did not lead to similar reductions in real-world CO₂ emissions:

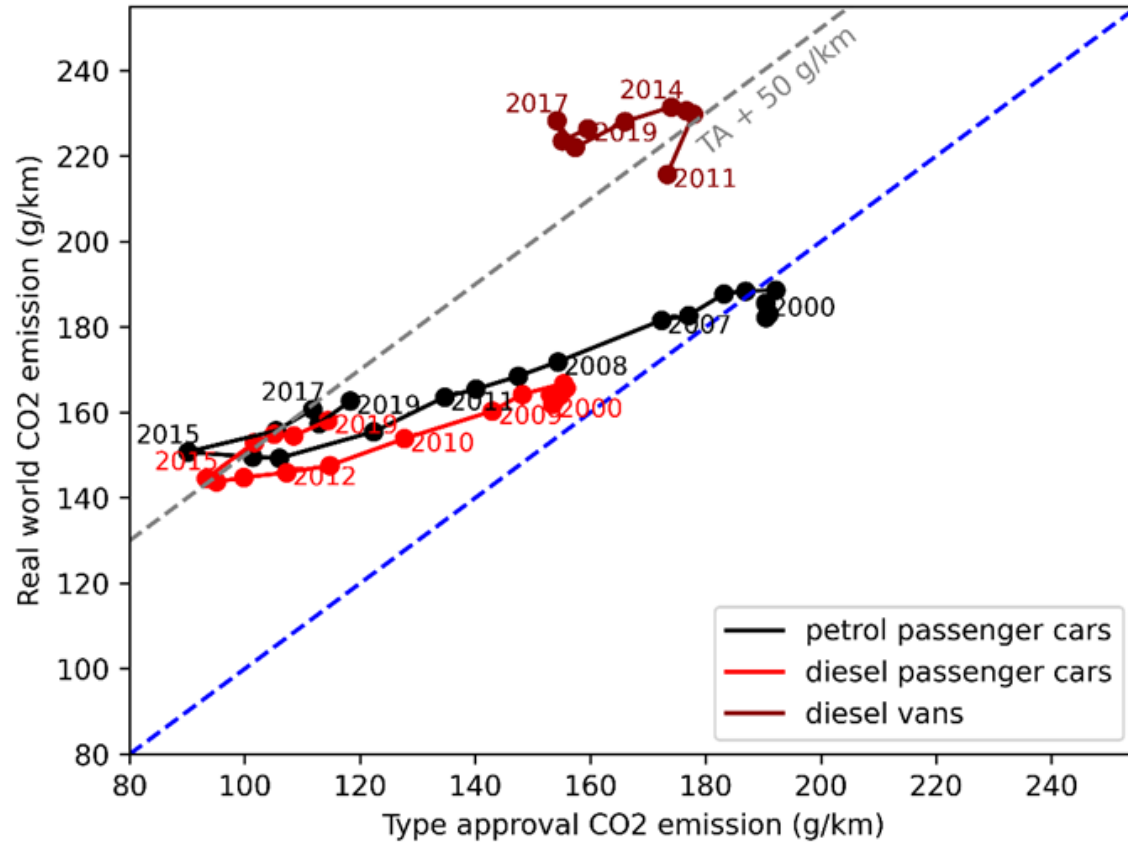
- › Real world reduction is not proportionally with the relative reduction on type-approval $\Delta\%$
- › Real world reduction is not proportional to the absolute reduction on the type-approval ΔCO_2 [g/km]

The mechanisms are not removed in the WLTP in 2017



TNO report 2015 R10730

PER MODEL YEAR PETROL, DIESEL, LCV ABSOLUTE DIFFERENCE THE BEST MEASURE OF THE GAP

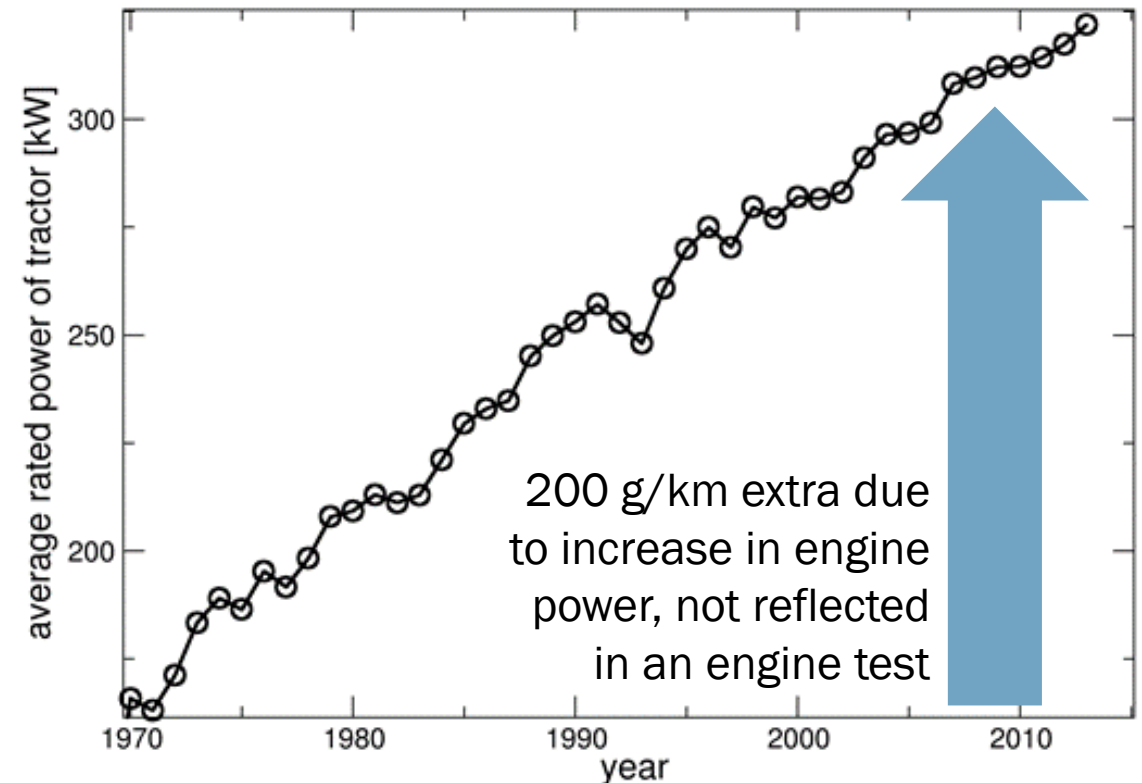


- › A year-by-year shift, started in 2008:
 - › Less than half effective for reducing real-world CO₂ emissions.
 - › All vehicle brands in the race-to-the-bottom
 - › Dutch national figures are adapted in 2010 to reflect the “gap”.
- › 5 Mton/yr of CO₂ missed if “official figures” (like EEA) are used, of the 35 Mton/year total for mobility in the Netherlands
- › The CO₂ values are increasing again with the changes in the tax system (towards electric vehicles)

HEAVY-DUTY VEHICLES ENGINE VERSUS VEHICLE

- › Heavy duty: many vehicles and uses with the same engine
 - › Certification of the engine
 - › Work based (g/kWh), tested relative to rated (max) power
- › Fuel consumption trucks: (~2015)
 - › Real world: $FC[l/100km] \sim 0.5 * \text{total weight [ton]} + 0.05 * \text{rated power [kW]}$
 - › *effects from driving behaviour and/or engine losses*
 - › about half of the fuel consumption is related to engine size, that increases with 3 kW per year.
 - › Engine tests are based on rated power [g/kWh], but its CO₂ result is considered “confidential” information.
- › Heavy-duty CO₂ certification is also confidential and based on a lot of simulations using “vehicle and usage standards”.
 - › Little seemed to be learned from the problems with light-duty vehicles.

Without transparency, Adam Smith’s “Invisible Hand” does not work. Current systems are protected by the secrecy.



CAR OWNERS AND USERS

VEHICLE AS LIFESTYLE CHOICE AND PERSONAL SAFETY BOX

- › The higher the speed limits on the motorway “require” the bigger vehicles and more power.
- › Japan has 100 km/h max speed limit and very cute (small) cars
- › Marketing of vehicles is not really about low fuel consumption, but about status, lifestyle, and exclusivity.
- › Engine power and weight increase continuously and CO₂ emissions with it

Fuel type	CO ₂ /kg g/(km*kg)
Petrol	0.084
Diesel	0.083
Hybrid petrol/electric	0.064
Hybrid diesel/electric	0.075
Plug-in Hybrid petrol/electric	0.075

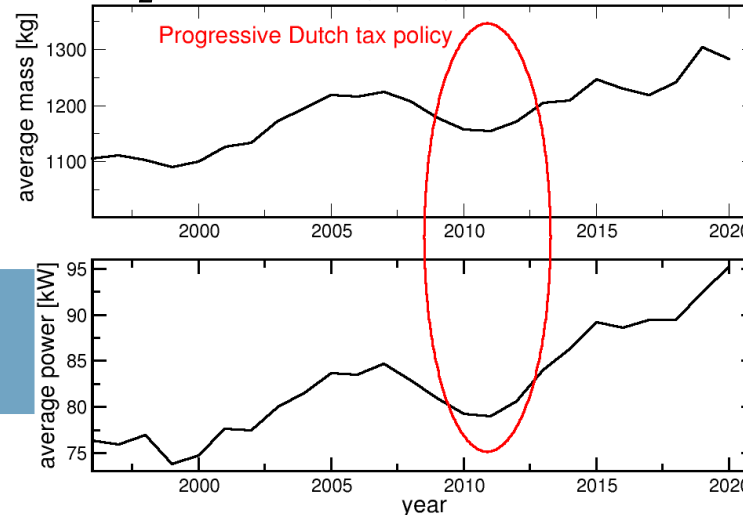
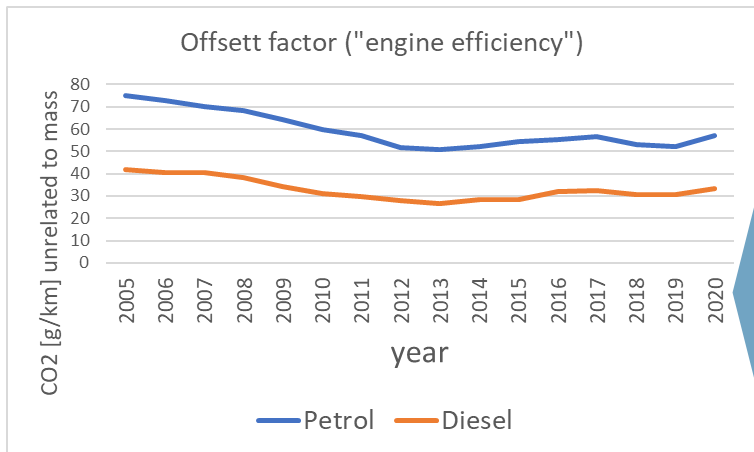
EU project: MILE21

real science aerodynamics



photo: DLR, from website WIRED

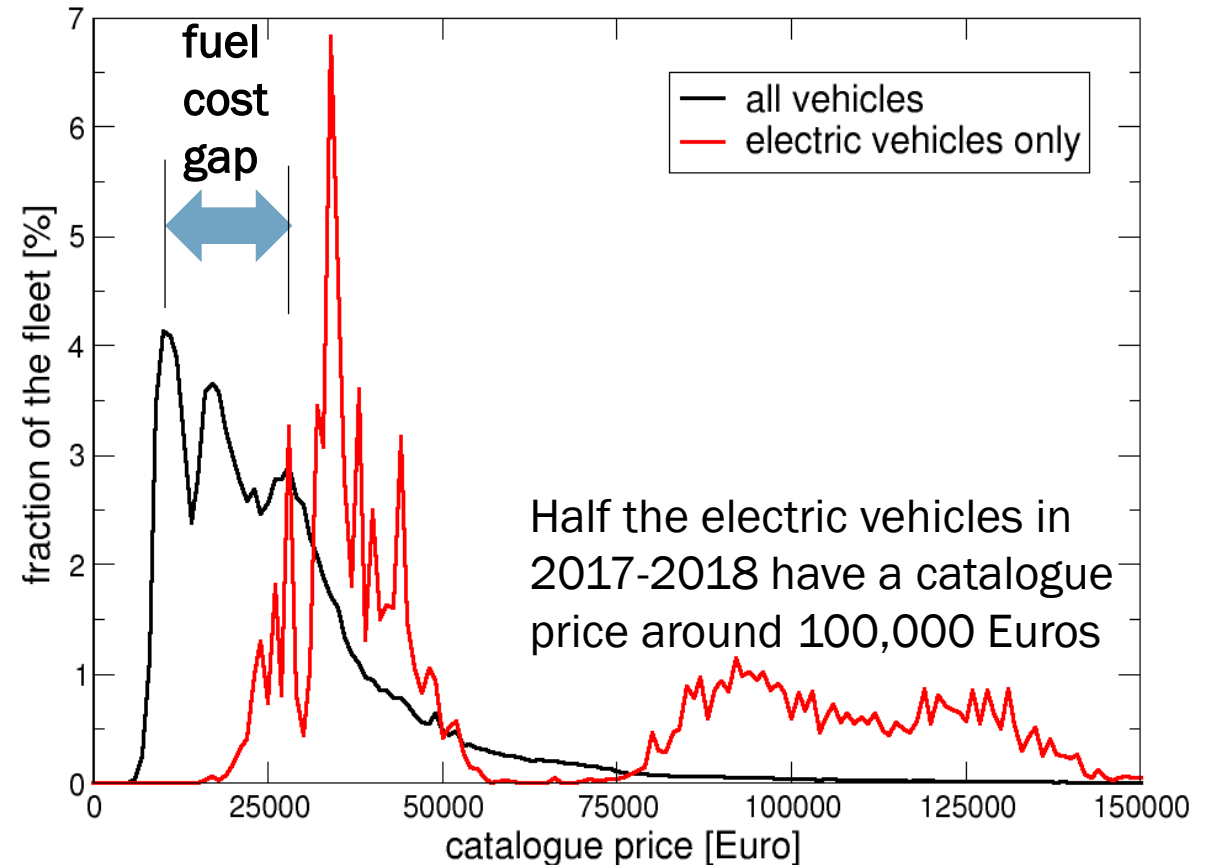
CO₂ is also (mainly) physics



› ELECTRIC VEHICLE SIMULATION IN THE NETHERLANDS

LOSING PUBLIC SUPPORT BY DRIVING-FOR-THE-RICH

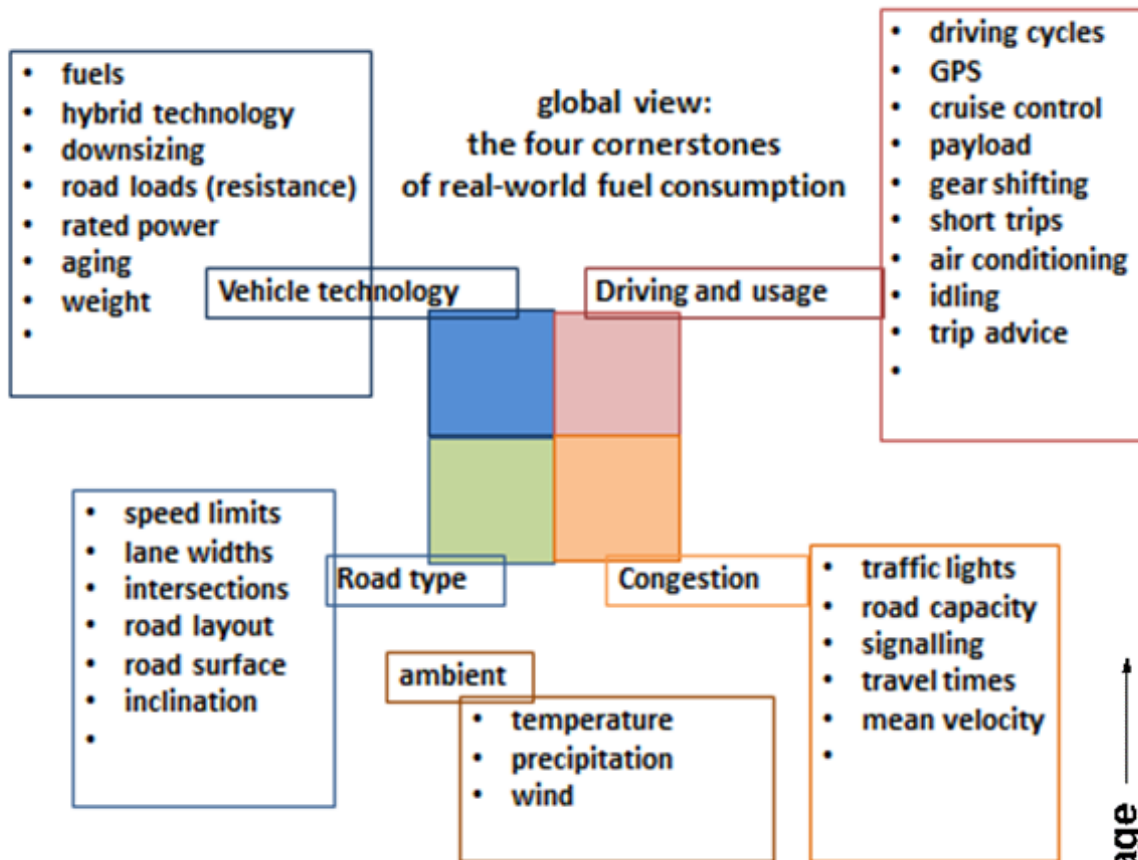
- › Electric vehicles have been a high-end business
- › Associated with +40.000 Euros subsidies in the Netherlands
 - › while 200,000 km lifetime driving ~ 20,000 Euros total fuel cost (assuming electricity is free)
- › Current policies do not include “average family” vehicle use (more than half of all vehicles):
 - › A- and B-segment vehicles
 - › second-hand 4-10 years old when bought
 - › replaced when “maintenance bill” is too high.
 - › no financing system: out of pocket costs
- › Large import of A- and B- segment vehicles and vehicles with high CO₂ taxes
- › Large export of subsidized and business-end cars



TNO report 2018 R10919

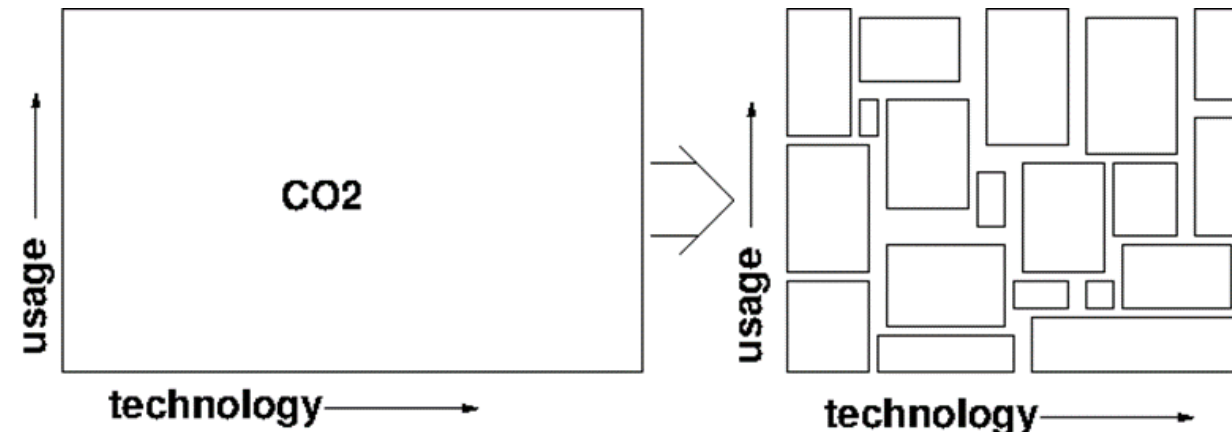
DO NOT DISENTANGLE THE DEPENDENCIES

INSTEAD IGNORE THE COMPLEXITY, AND RETURN TO BASICS



Dominant dependencies in real-world fuel consumption:

1. Weight of the vehicle (~70%)
2. Fuel (~17%)
3. Model year (~13%)



› **ATTEMPTS TO CHANGE THE (EU) SYSTEM BY ADDING CONTROL ON-BOARD FUEL CONSUMPTION METERING AND INDEPENDENT TESTING**

25.4.2019

EN

Official Journal of the European Union

L 111/13

REGULATION (EU) 2019/631 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 April 2019

setting CO₂ emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011

(recast)

(Text with EEA relevance)

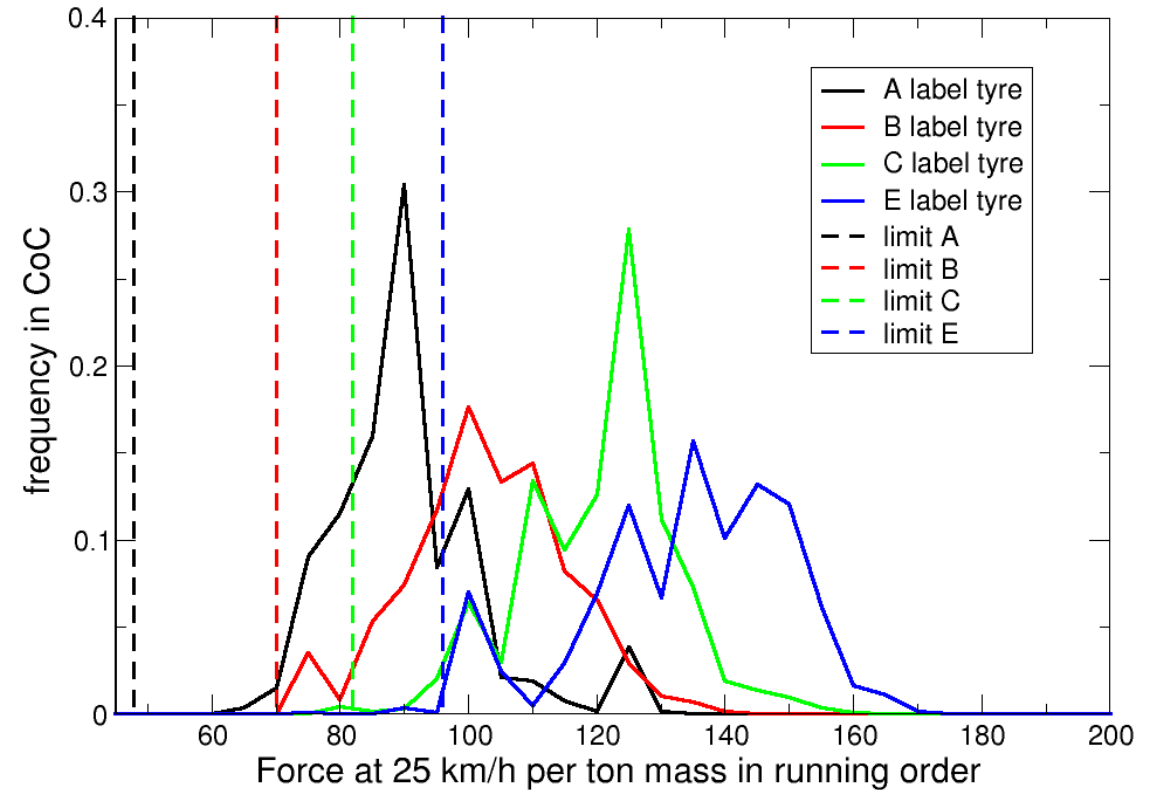
THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

- › Monitoring of fuel consumption by validated fuel consumption metres (Article 12)
 - › no remedial actions associated with On-Board Fuel Meter (OBFCM), “monitoring” until 2025
- › Testing of fuel consumption and CO₂ to verify the manufacturer declared value (Article 13)
 - › In-Service Verification testing and remedial actions, a task for type-approval authorities

› CERTIFICATE OF CONFORMITY CONSUMER INFORMATION

- › Information for the vehicle owner provides now more information:
 - › CO2 emission per phase (urban, rural,)
 - › weight, weight, tyres, tyre labels.
- › With the NEDC the driving resistance was often unrealistic low, lower than the rolling resistance of the tyres.
- › Now the driving resistance can be checked against the driving resistance of the tyres (given the tyre labels).
 - › Some vehicle models are already very close to the physical limit.

CoC information of different vehicle models



› **JOINT DUTCH EFFORT TO GENERATE MORE TRANSPARENCY PROVIDING FUEL CONSUMPTION DATA IN ALL DETAIL**

- › **Together with Statistics Netherlands TNO has developed the “bottom-up approach”:**
 - › Every vehicle in the Netherlands has an individual real-world CO₂ emission estimate (~15 millions vehicles)
 - › These results are multiplied with the actual mileages of the vehicles as registered by the road authority (~120 billion kilometers)
 - › Urban/rural/motorway shares are based on annual mileage of the vehicle and used in real-world estimate
- › **This data is shared with parties who develop models and tools to determine impact:**
 - › In policy development and policy assessment
 - › Data will be available for downloads for transparency
- › **Any differentiation and presentation is possible**
 - › Zoom in and zoom out
- › **Hopefully OBFCM will further improve this approach**
 - › Data is the start, but without sharing, augmenting, linking and presenting data it only has the “air of authority”

out of the box

› COLLAPSING THE BLAME TRIANGLE JOINT RESPONSIBILITIES

- › Shared fuel costs above 95 g/km (LD) and $95 \text{ g/km} + 25 \text{ g}/(\text{ton}-3.5) * \text{km}$ (HD), or less
 - › OEM pays part of excess fuel cost and taxes up to 5 years of use
- › Lease contracts only, fuel included, with user instructions.
 - › Ensuring the right information for using and keeping cars efficient and clean
- › Road taxes based on On-Board Fuel Consumption Meter data.
 - › Presenting the personal climate bill



LEAVING THE BLAME TRIANGLE

RETHINKING CURRENT MOBILITY AND TRANSPORT

- › Return to the weight-based taxing and subsidy systems
 - › Mobility requires only 600 kilograms; the rest is ego, safety, comfort, and utility
- › Reduce motorway speed limits to 90 or 100 km/h, with instant and long-term effects
 - › Also beneficial for stimulating affordable, energy-efficient electric vehicles (~20 kW)
- › Limit access to inner cities, make it pedestrian zones with cycle lanes
 - › more livable and safe cities



source: autoevolution.com

› CONCLUSIONS

THE UNRESOLVED PROBLEMS WILL AFFECT THE FUTURE

- › Taking a step back from the CO₂ emissions of vehicles policies after ten years of limited effectiveness.
- › There is a tendency to follow the white rabbit down the rabbit hole of technical problems and technical solutions.

- › Policies should establish a direct link with bottom line, i.e., litres of fuel, and kilograms of CO₂
 - › and the allocation of sources as in Kyoto treaty and by IPCC guidelines:
 - › **Kyoto:** *a national system for the estimation of anthropogenic emissions by sources (i.e., Sectors/source categories → Energy → Fuel combustion → Transport)*
 - › **IPCC:** *[Transport] Emissions of CO₂ are best calculated on the basis of the amount and type of fuel combusted and its carbon content.*

- › A shift the focus in policies from tests, declared values and technologies towards actual fuel consumption is needed:
 - › Not only new vehicles, but all vehicles (with immediate effects, not after 10 years)
 - › Back to basics, e.g., by reducing vehicle weight, motorway velocity and vehicle use.

TALKING HEADS' WE ARE ON A ROAD TO NOWHERE

WELL, WE KNOW WHERE WE'RE GOING
BUT WE DON'T KNOW WHERE WE'VE BEEN