

Post-Diesel mobility with or without Diesel?

66th LCA Discussion Forum

LCA of Mobility solutions: approaches and findings

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Agenda

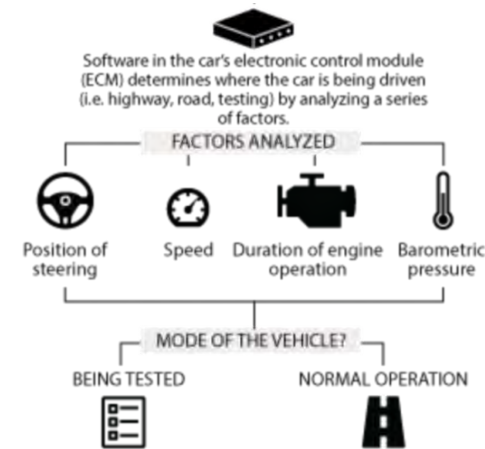
- NOx-problem
 - Scandals: Difference between the VW- and the general diesel-affair
 - Regulations: Past and Future
- Can the Diesel engine survive?
 - Real world CO2 vs. real world emissions
- How to assess real world energy demand for different technologies?

Scandals

Difference between the VW- and the general diesel-affair

■ VW Scandal

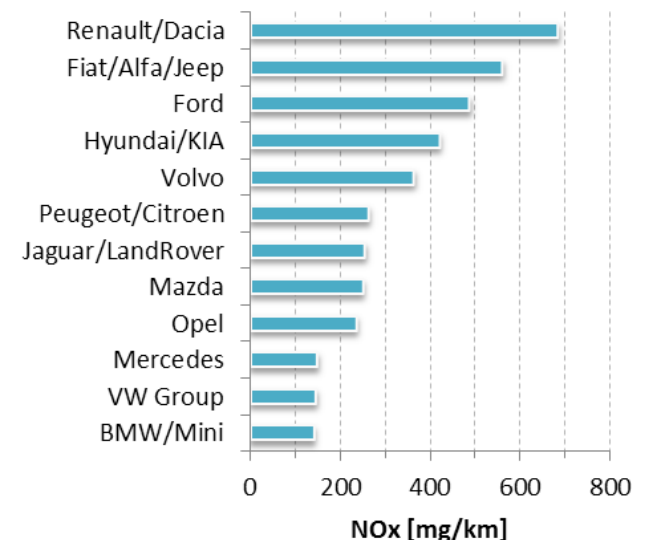
- Customised software that enabled diesel engines to detect when a car is undergoing an emissions test
- Turned on full emissions controls for NOx only during tests



Source: Reuters/EPA

■ Diesel Scandal

- Optimising emission controls for dyno operation only
- Switching off of emissions controls according to ambient conditions
- Generous interpretation of the weak regulations by the manufacturers



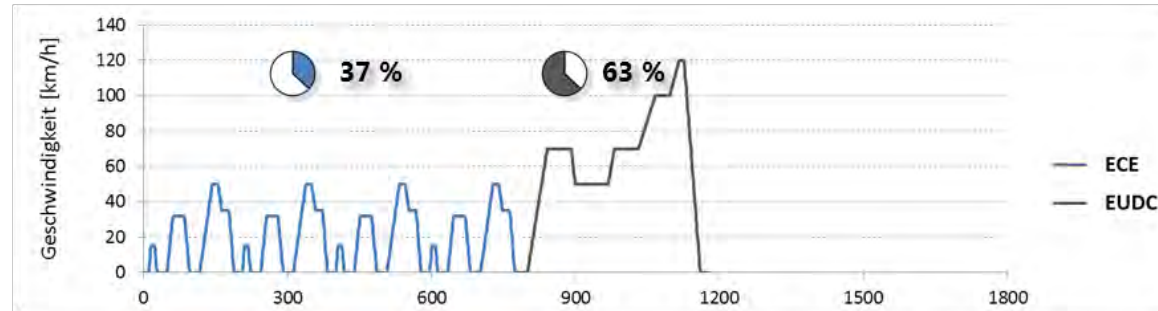
NOx emissions during of the ADAC eco test (188 vehicles)
Source: ADAC e.V. , 08.2017

Regulations

Past and Future - WLTP (Worldwide Harmonized Light-Duty Vehicles Test Procedure)

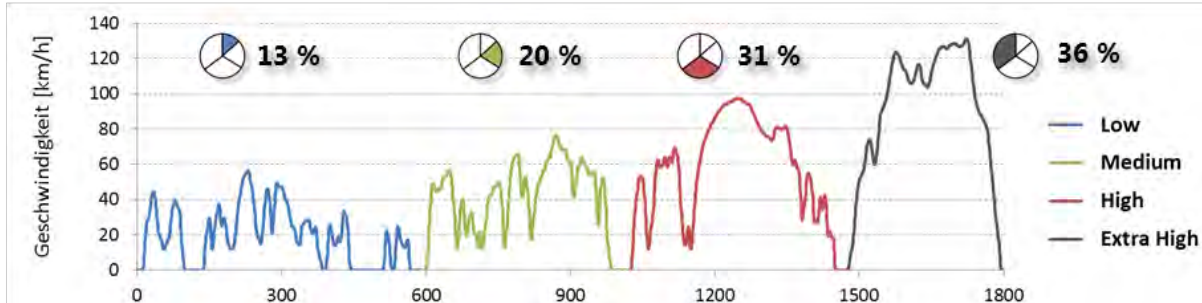
NEDC

d_{tot} 11 km
 v_{max} 120 km/h
 a_{max} 1.0 m/s²
 v_{mean} 34 km/h



WLTC

d_{tot} 23.25 km
 v_{max} 131 km/h
 a_{max} 1.7 m/s²
 v_{mean} 46.6 km/h



- New driving cycle
 - Longer, more realistic driving cycle
 - Vehicle individual gear shift points
 - Higher average and peak power demand
- More realistic weight setting

Regulations

Past and Future - RDE (Real Driving Emissions Test)

- The vehicle is equipped with a mobile emission measurement system (PEMS)
- The vehicle is operated in normal traffic situations
- Recorded data:
 - Emission concentrations
 - Exhaust mass flow
 - Ambient conditions
 - GPS Data
 - OBD-vehicle
- Data evaluation and emission compliance according to RDE legislation



Source: Empa, APTL



Source: AVL.com

Regulations

Past and Future

■ Euro 6b

- Chassis dyno test only (NEDC)
- No real driving emissions test
- Last selling date: 31.08.2018



■ Euro 6d

- Chassis dyno test (WLTP)
- Mandatory RDE test, with NOx conformity factor: 1.5

■ Euro 6c

- Chassis dyno test (WLTP)
- RDE test, for monitoring purposes only, no emission limits
- Last selling date: 31.08.2019

■ Euro 6d-TEMP

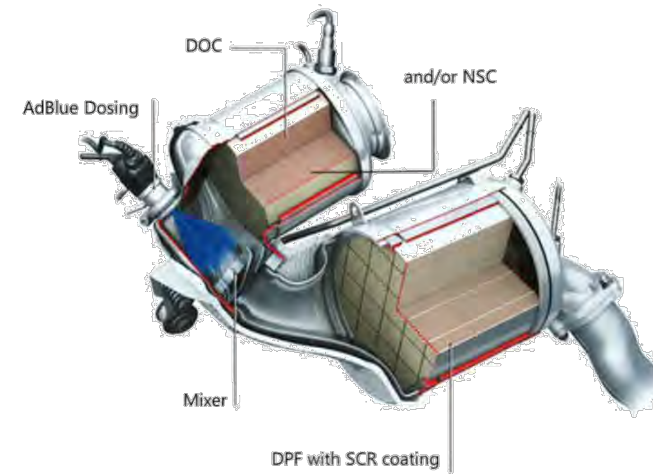
- Chassis dyno test (WLTP)
- Mandatory RDE test, with NOx conformity factor: 2.1
- Last selling date: 31.12.2020

Can the Diesel engine survive?

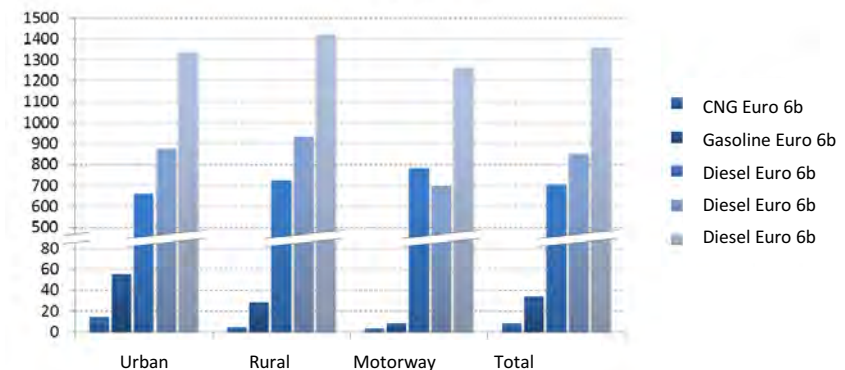
Real world CO₂ vs. real world emissions

- New legislation will force the manufacturers to build clean vehicles
- Technology to build clean diesel engines is available but expensive
- Smaller diesel engines might be not cost effective for the manufacturers and might therefore disappear from the market
- Manufacturers have to balance the costs, pollutant emissions and CO₂ emissions to find the ideal, marketable drive train

State of the art SCR System (Source: ATZ/MTZ)



NO_x [mg/km]



NO_x emissions of different vehicles with simple exhaust aftertreatment systems (CNG & Gasoline: TWC; Diesel: DOC, EGR, DPF; Source: Empa)

How to assess real world energy demand for different technologies?

NEDC dyno cycle - some similarities to the diesel scandal

- Difference between NEDC and real world fuel consumption increases from year to year
- Vehicles are optimised for dyno operation
- The NEDC doesn't represent real world driving (no dynamics, no auxiliary consumers, low engine load)

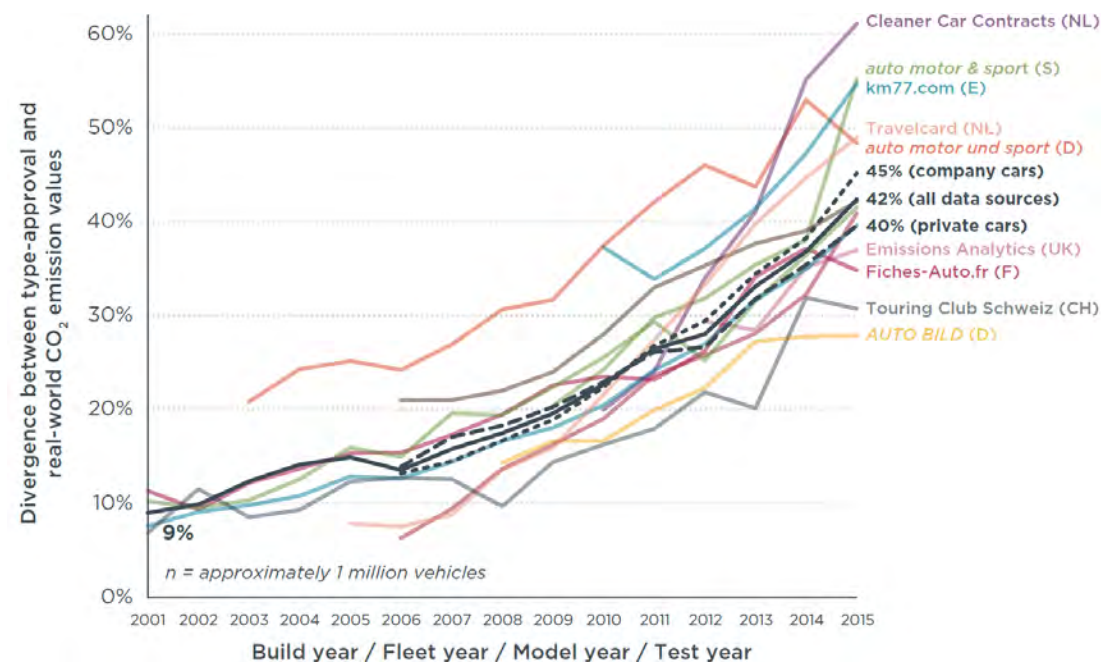


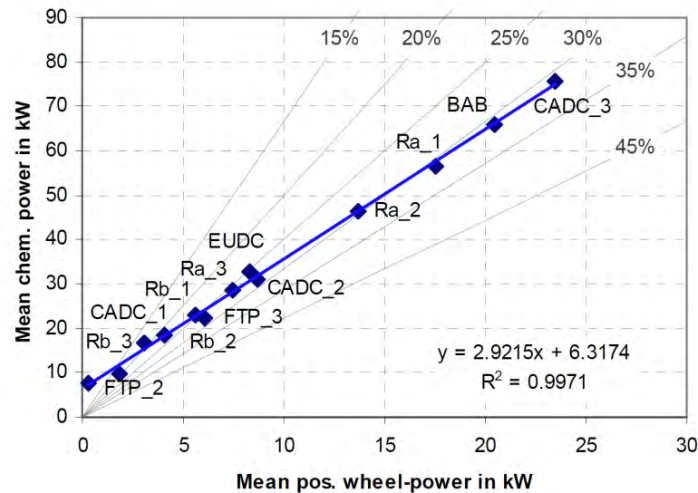
Figure ES- 1. Divergence between real-world and manufacturers' type-approval CO₂ emission values for various on-road data sources, including average estimates for private cars, company cars, and all data sources.

Source: ICCT White Paper: FROM LABORATORY TO ROAD; A 2016 UPDATE

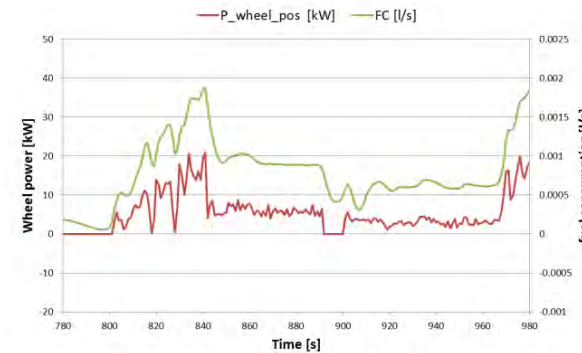
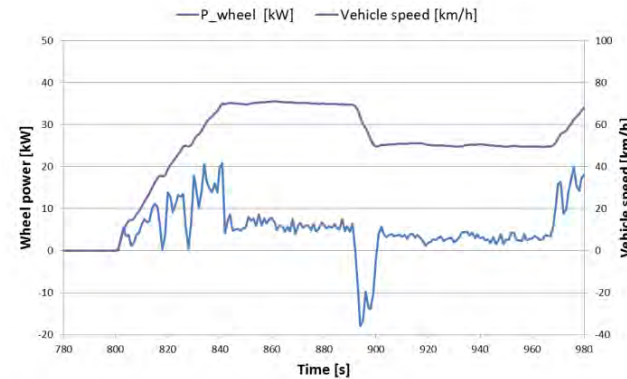
How to assess real world energy demand for different technologies?

Willans-Approximation

- Comparison of wheel power demand and chemical power input



Source: SAE Paper "CO2 Reduction and Cost Efficiency Potential of Natural Gas Hybrid Passenger Cars", Bach & Soltic Empa

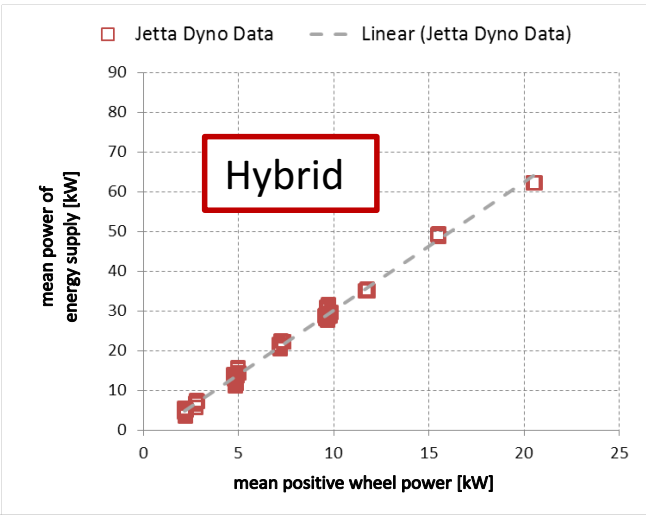
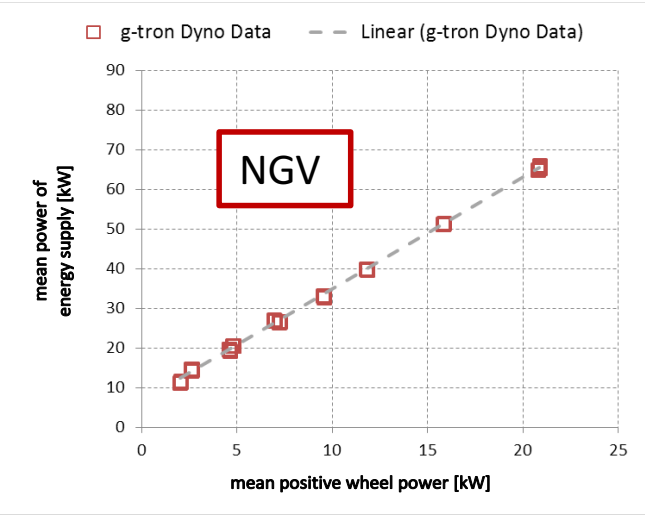


- The aim is to develop a tool to calculate real world energy demands according to type approval data (WLTP sub cycle results)

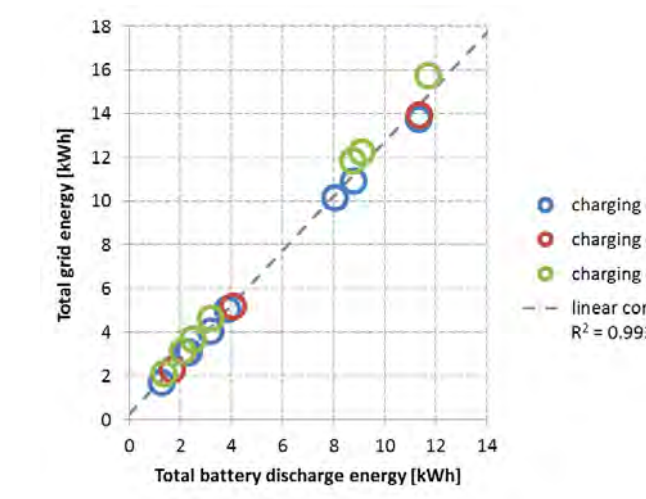
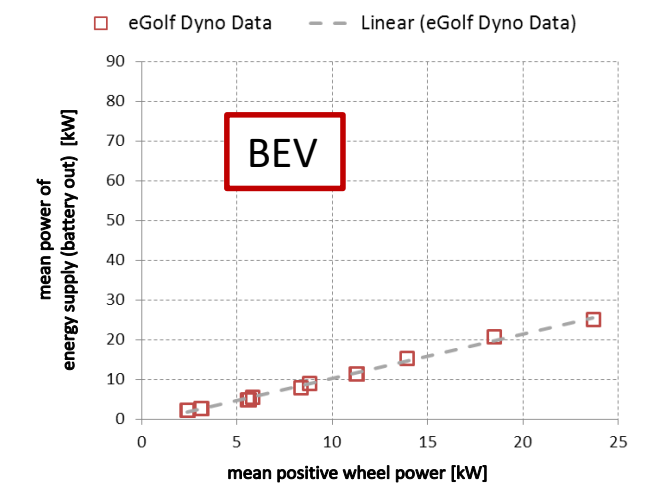
How to assess real world energy demand for different technologies?

Characterisation of different drive train technologies

Conventional and Hybrid drive trains



Battery electric vehicle



Thank you for your attention!

With a sincere vote of thanks to:

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