

DAIMLER

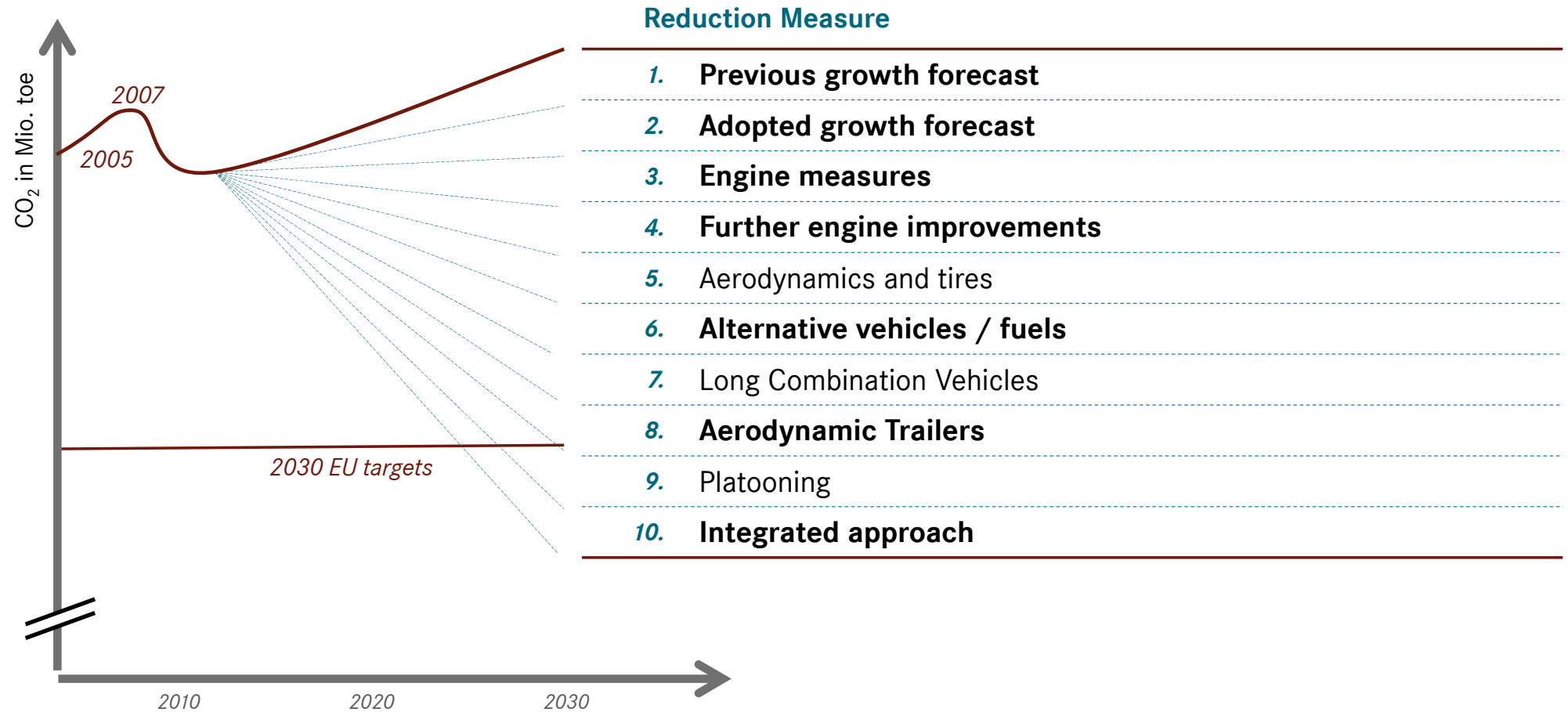
Daimler's advances in fuel efficiency and zero emission activities

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Brussels, 2016, Nov. 8

Daimler Trucks

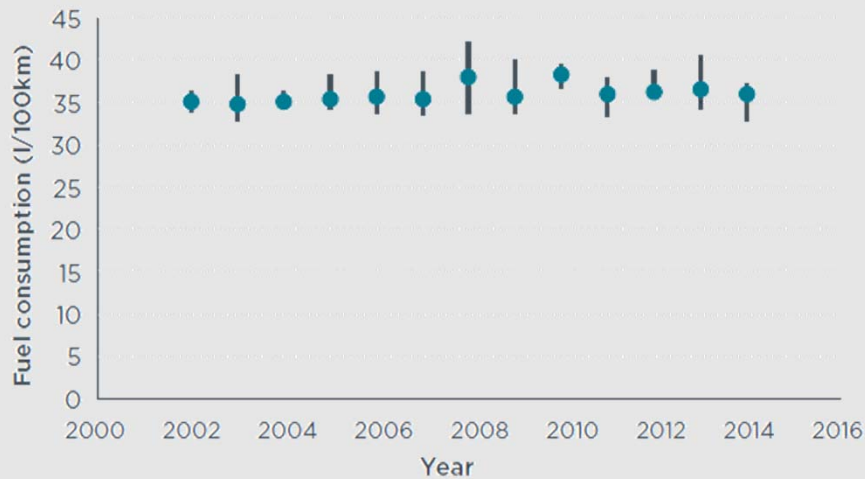


Do we need CO₂ limits for HDVs to fulfill European climate targets? An OEM perspective



Validation of ICCT data: Truck industry with improvements of more than 20% since 1996 in fuel consumption

ICCT states no FE progress (December 2015)



Comments:

- No comparable figures due to changing test routes and different vehicles (4x2, 6x2, 8x4; 400-650hp)
- Different time frame for tests (traffic conditions differing)

Source: "Lastauto-Omnibus" real driving test results

Validation of ICCT data (August 2016)



Vehicle 1
from 1996
engine OM 442 LA
436 hp, Euro I



Vehicle 2
from 2003
engine OM 501
456 hp, Euro III



Vehicle 3
from 2016
engine OM 471,
FEPO pkg.
450 hp, Euro VI

SK 1844 LS

average fuel consumption
40.8 l/100 km

Actros MP2 1846

average fuel consumption
37.4 l/100 km

Actros SFTP 1845

average fuel consumption
31.9 l/100 km

reduction vs. vehicle 1:
3.4 l/100 km \cong 8.3%

reduction versus vehicle 1:
8.9 l/100 km \cong 21.8%

reduction versus vehicle 2:
5.5 l/100 km \cong 14.7%

supervised by
 DEKRA

Real-life results (lastauto omnibus, supervised by DEKRA):

- Within 20 Years: Reduction of nearly 22% diesel consumption
- Also a reduction of more than 95% NOx and PM
- If we could have used 1996 tires: Improvement would have been even more !

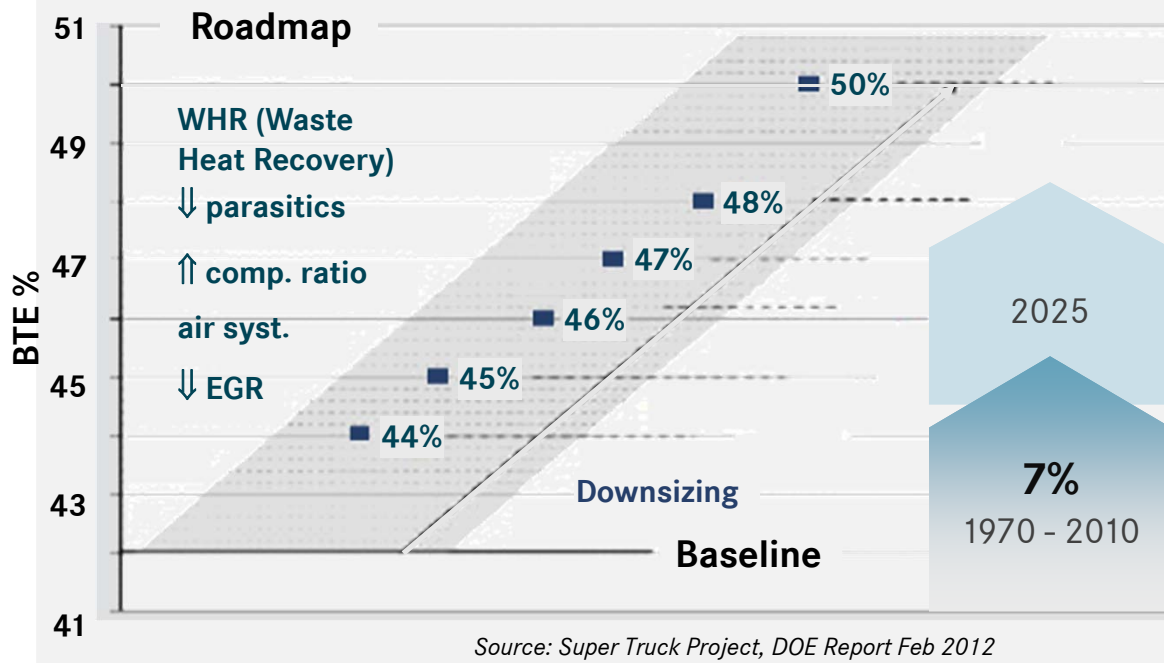
Source: "Lastauto-Omnibus, Sept. 2016"

Improvement of thermal efficiency only in small steps; heavy-duty engines already close to their physical maximum



Continuous development work and improvement

Approaching 50% Brake Thermal Efficiency (BTE)



MB Trucks: Latest engine update: 2 % fuel consumption improvement released in 2015/16

- Fuel injection system 2nd generation X-Pulse
- Reduced friction
- Proprietary asymmetric turbocharger
- Enhanced combustion
- Unique EGR valve technology

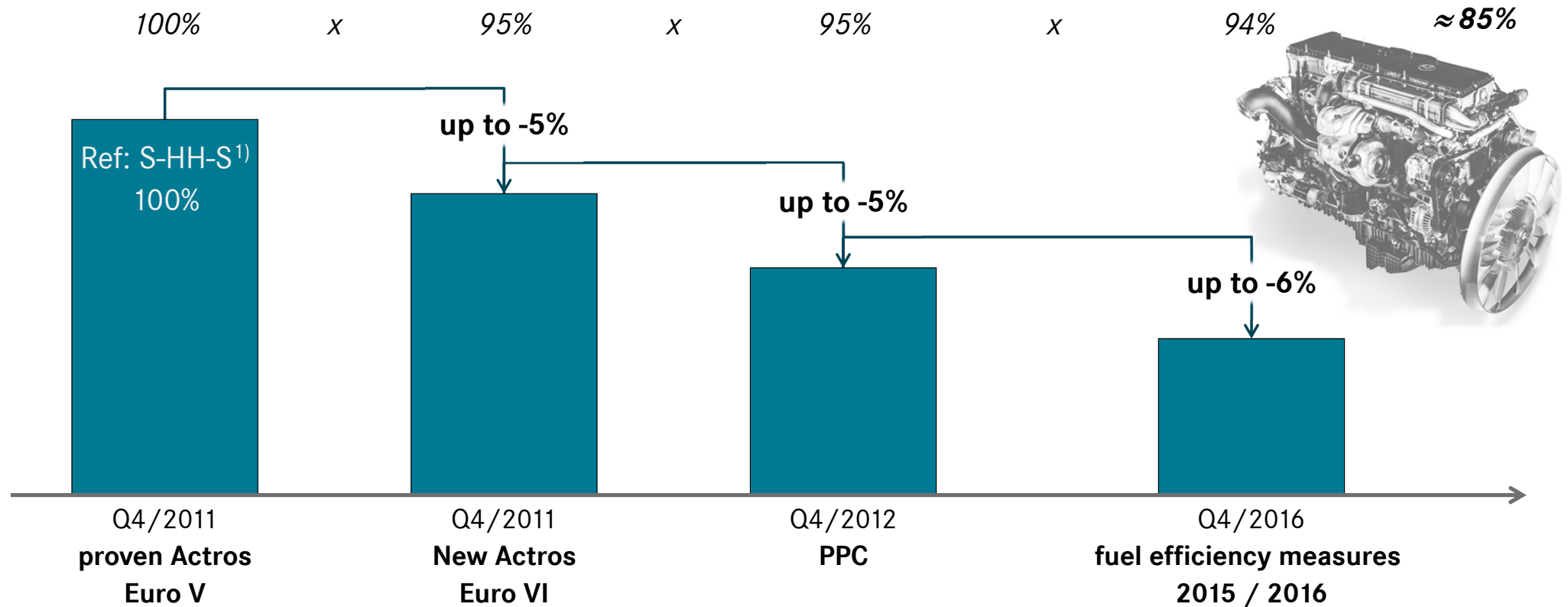


- Research is under way to improve efficiency of heavy duty engine further.
- Cost efficiency as critical industrial parameter.

Efficiency as challenge: Fuel consumption reduced by up to -15% within 5 years! Average optimization: More than -1.5% per year



Introduction of further fuel efficiency measures in summer 2016



1) MB Trucks reference test track: Stuttgart-Hamburg Hamburg-Stuttgart, 100% cruise control: 85 km/h

We look into each segment and strive for improvements

Daimler Trucks: E-mobility in distribution segments

Fuso eCanter for LD distribution



Permanent magnet engine, 400 V

- P_{\max} : 110 kW
- Max. torque: 650 Nm
- Battery capacity: 48.4 kWh
- Range: 100 km
- Chassis: 7.5 t
- Payload: 2 t

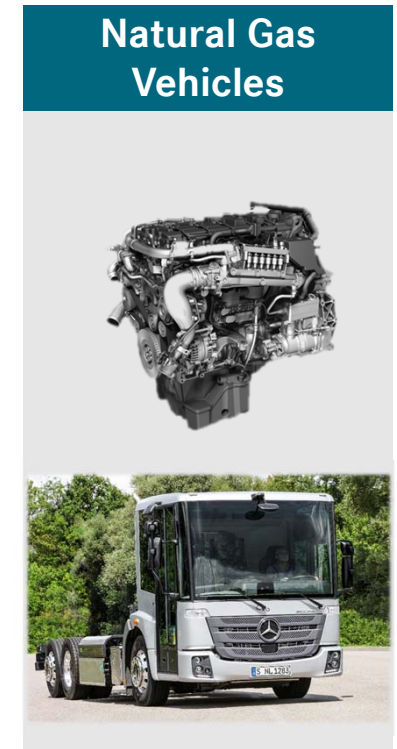
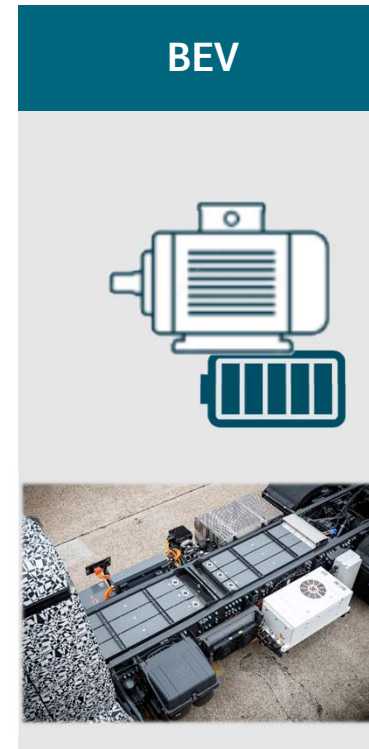
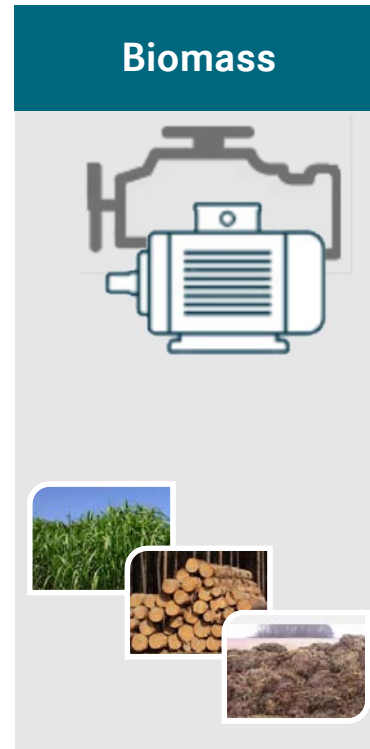
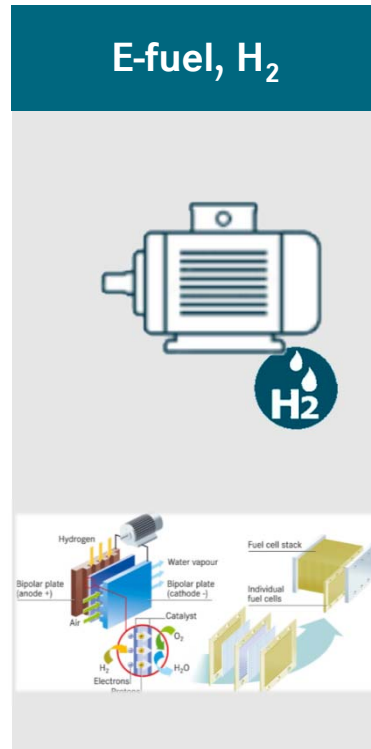
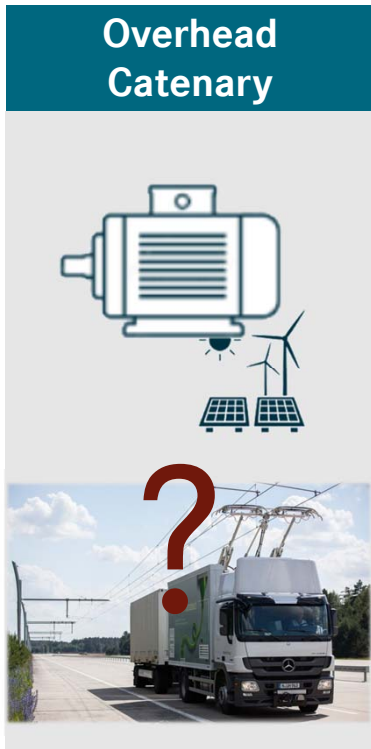
Mercedes-Benz Urban eTruck for HD distribution



HV Electric Drive ZF AVE 130-400 VAC modified

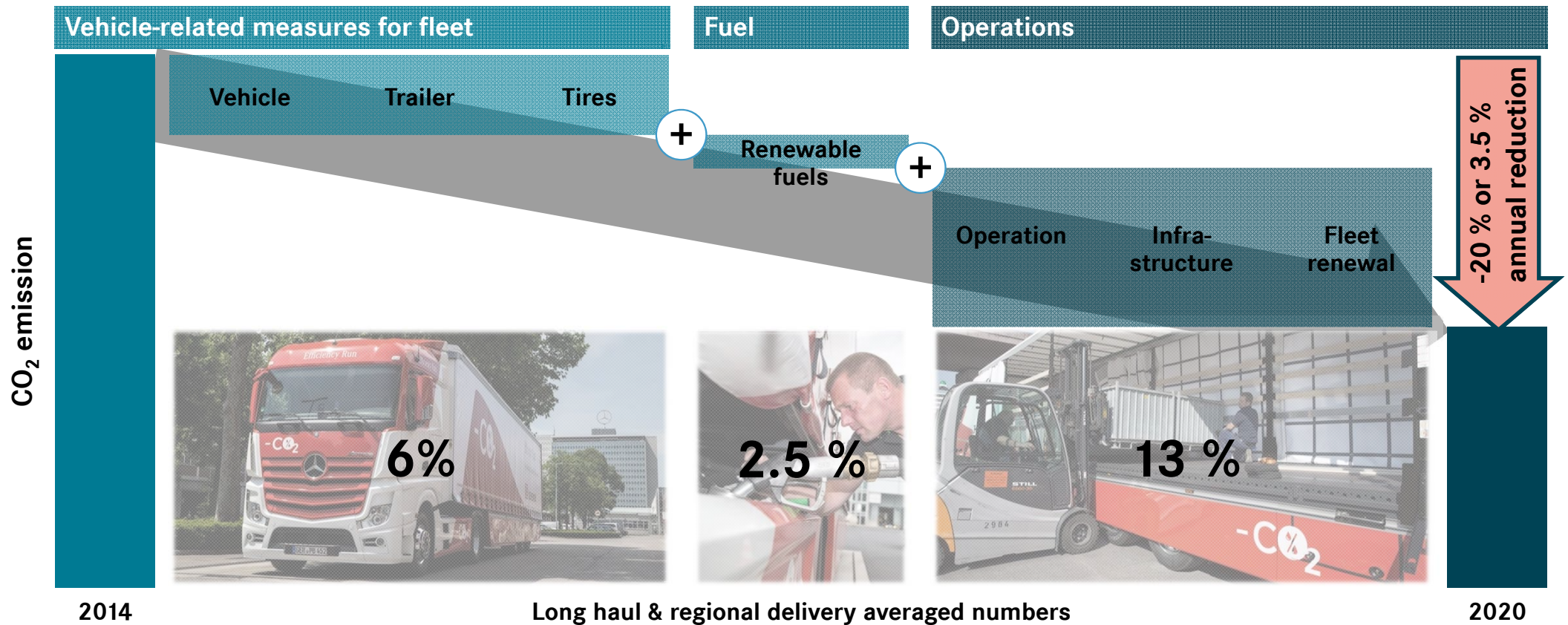
- P_{Peak} 2 x 125 kW / P_{Cont} 2 x 60 kW
- Max. torque: M_{\max} 2 x 500 Nm
- Battery capacity: 212 kWh
- Range: up to 200 km
- Chassis: 25t
- Payload: 11 t

Despite other technologies in the diesel field we analyze all long-term options for long-haul



- Do we need now a decision on the way beyond 2030 ?
- How will EU 27 power generation look like in 2030 and 2050 ?
- How much and how long will politicians support costly options ?

If all stakeholders join forces, EU can achieve around -20% CO₂ emissions over the next 6 years: Annual reduction rate 3.5 %



By all these measures, we will contribute to European CO₂ reduction targets

Without any regulation significant progress also in the European trailer industry – proven in the Efficiency Run 2



Fuel consumption/CO₂ emission reduction of up to 20% - compared to standard vehicle combination of 2014



Up to 20% improvements and everything can be purchased today!

PPC* up to 5 %

Semi tractor up to 6 %

Krone Profi Liner Efficiency trailer: more than 5%

A-lable tires: 2 - 4 %

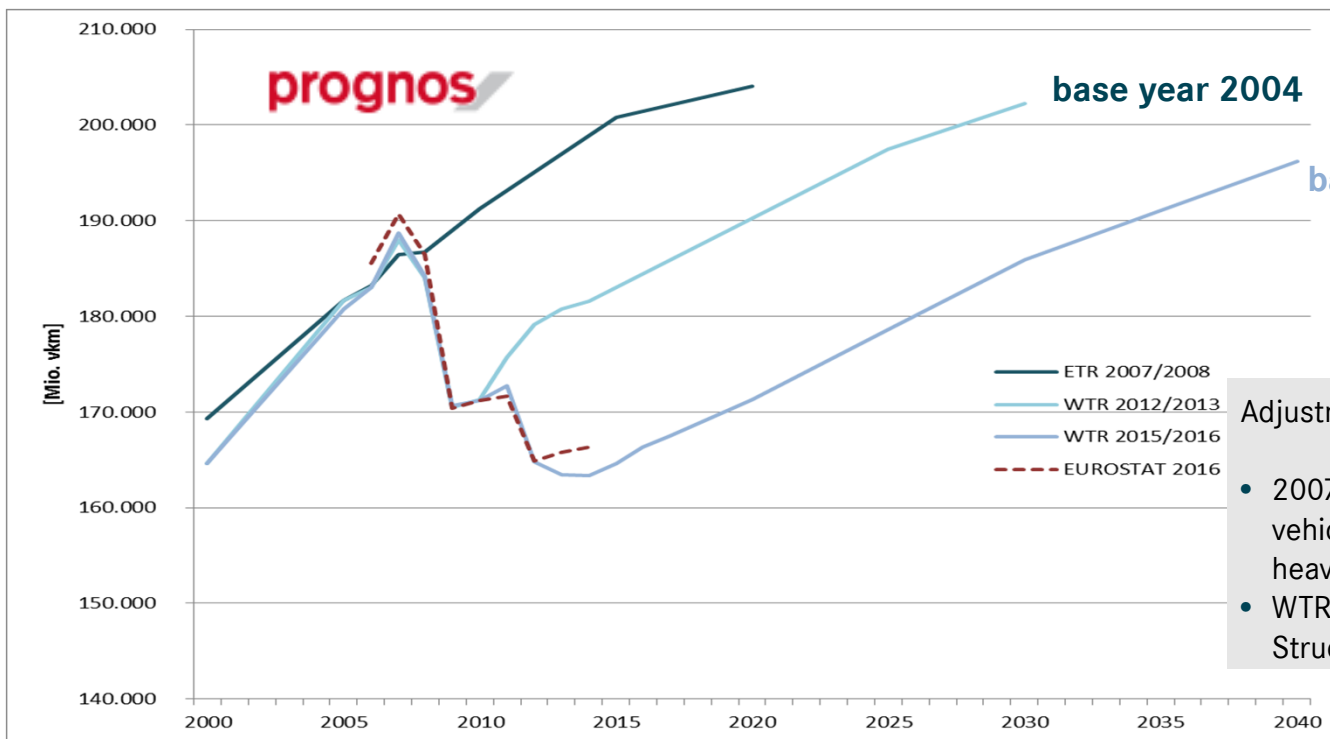
* PPC: Predictive Powertrain Control

Forecasts expect growth in heavy-duty vehicle mileage

Effective growth rates much lower than forecasted



EU 27 forecasts vehicle mileage EU 27 [bn. km] – Prognos forecasts



Adjustments / assumptions:

- 2007 figures heavy-duty vehicles and light commercial vehicles; structure of WTR 2012 used to concentrate on heavy-duty vehicles
- WTR 2015 figures for EU 12; Structure of WTR 2012 used to extrapolate to EU 27






EU 27 vehicle mileage still far below 2007 pre-crisis level – 2007 level will be reached again around 2030

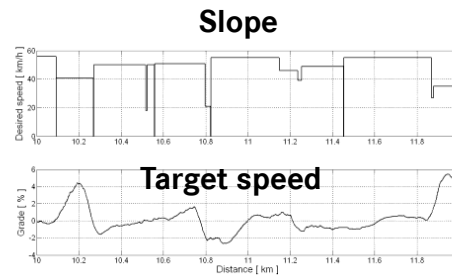
VECTO: Will bring further competition into each segment and therefore lead to significant CO₂ improvements

Full-vehicle simulation approach to reflect the variety of HDV vehicles and their use

Representative boundary conditions depending on vehicle class
(same for all OEMs)

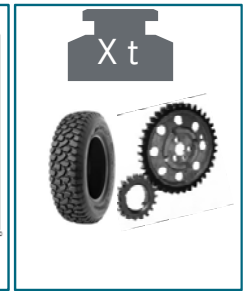
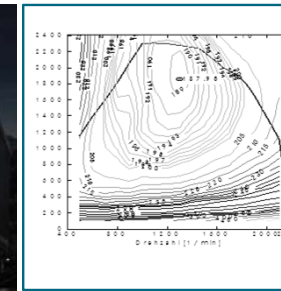
Cycles for each vehicle class

Long-haul		• mainly highway operation and a small share of regional roads.
Regional delivery		• inner city, suburban, regional roads
Urban delivery		• inner city and partly suburban roads
Municipal utility		• many stops, partly low vehicle speed
Construction		• inner city, regional roads; minor share off-road driving



Standard trailer / body specification

Certified input data from OEM
(OEM-specific)



Cert. driving resistances:
- driven axle
- transmission
- air drag
OR
standard values

Certified engine fuel map

OEM specific values
- Weight
- ratios
- tires



VECTO simulation tool *(same for all OEMs)*

CO₂ and fuel consumption values

Do we need CO₂ limits for HDV to fulfill European climate targets? An OEM perspective

CO₂ declaration overview - simulation procedure



Some reflections ...

... on an European CO₂ regulation for heavy-duty vehicles

- Trucks and buses are not just bigger cars !
- No discrimination of vehicle segments
- VECTO must be the basis (cost effective improvement potential !)
- Component specific limits do not reflect cost effectiveness and thus to be rejected
- The heavy duty vehicle business is very dependent on economic cycles
- Improvements require long lead times
- ...

Summary and outlook

The heavy-duty truck industry in Europe is the leader in fuel economy – without any CO₂ regulation

Within the last 8 years a tremendous progress has been made in the technology development of trucks and buses – reducing criteria pollutants and in parallel improving fuel economy

Driven by TCO and competition the heavy-duty truck industry will continue to implement cost-effective technologies

The EC simulation approach is the right way to go: simulating the fuel consumption of a specific vehicle by a robust and comparable procedure

Europe should push other markets to adopt this simulation procedure as soon as possible

