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Emission reductionpotential of hybrid vehicles

Study performed by Consortium
VUB – TNO and EMISIA

DEPARTMENT OF
ENVIRONMENT
& SPATIAL
DEVELOPMENT

Presentation by Natacha Claeys in cooperation with Giorgos Mellios and Nils Hooftman

Why study Zero-Low-Emmision vehicles (ZLEV)?

Goverments and PHEV's

- International and EC legislation:
  - → Climate change and air quality directives
  - → CO_2 regulation of cars, light duty vehicles, heavy duty vehicles
  - → Clean Power for Transport
- National and regional goverments' motive
  - → PHEVs as 'way-maker' for EVs and economic viability charging infrastructure
  - → Potential technology for electric driving most of the time
  - → More efficient power trains = CO_2 down
  - → Improving local air quality
- Emission inventory
  - → Reporting road transport emissions

Results of the study

- Part I ’Literature’ study for LDV and HDV
- Part II ‘Measurement campaign of PHEV –M1-cars’
- Part III ‘Modelling real emission factors for PHEV – developmentof methodology’
  - New actual EF M1-cars/bus

→ See presentation of EMISIA (Giorgos Mellios)

- Part IV ‘Additional reduction potential for cars in the future’
- Part V ‘Impact assessment on M1’
  - → EF
  - → EIV (actual/ projections)
- Policy lessons?
- Future studies necessary?

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Actual M1-cars

See presentation of EMISIA
(Giorgos Mellios)

The benefits of the PHEVs are actually coming from the electric (CD) part of the vehicle operation, rather than from the ICE (CS). This reflects in the results of the UF.

UF		
Urban	Rural	Highway
0,5	0,5	0,2

Addditonal reduction potential for futures cars M1

Future PHEVs scenarios

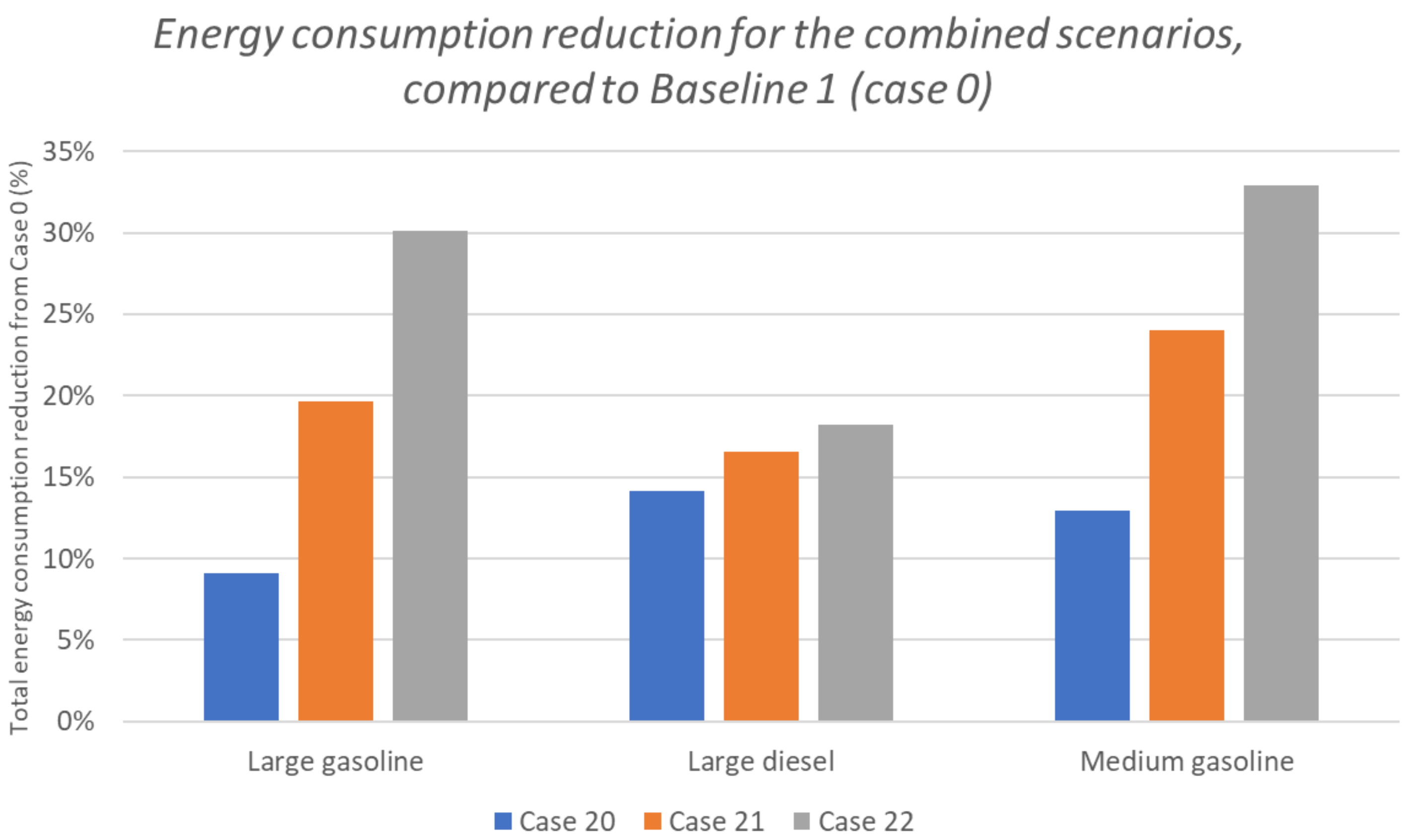
- Parameters studied
  - → Road load
    - × Reduction in tyre-road friction (F_0)
    - × Reduced aerodynamic drag (F_2)
  - → Thermal engine efficiency
  - → Vehicle weight
  - → Battery and electric motors
- **Changes based on literature and analysis of the EEA database**

Simulation cases

- For each parameter the improvements were divided in three steps, with the first being the least optimistic scenario and the third the most optimistic

Change in:	F_0 (%)	F_2 (%)	ICE eff. (%)	Battery Capacity (%)	Weight (%)	El. motor eff. (%)
Case 0	0%	0%	0%	0%	0%	0%
Case 1	-4%	-10%	0%	0%	0	0%
Case 2	-12%	-20%	0%	0%	0	0%
Case 3	-22%	-30%	0%	0%	0	0%
Case 4	0%	-10%	0%	0%	0	0%
Case 5	0%	-20%	0%	0%	0	0%
Case 6	0%	-30%	0%	0%	0	0%
Case 7	0%	0%	10%	0%	0	0%
Case 8	0%	0%	20%	0%	0	0%
Case 9	0%	0%	30%	0%	0	0%
Case 10	-12%	-20%	20%	0%	0	0%
Case 11	-12%	-20%	20%	0%	-4%	0%
Case 12	-12%	-20%	20%	0%	-8%	0%
Case 13	-12%	-20%	20%	0%	-12%	0%
Case 14	-12%	-20%	20%	0%	0%	3%
Case 15	-12%	-20%	20%	0%	0%	6%
Case 16	-12%	-20%	20%	0%	0%	9%
Case 17	-12%	-20%	20%	20%	-1.9%	0%
Case 18	-12%	-20%	20%	40%	-1.6%	0%
Case 19	-12%	-20%	20%	60%	-1.3%	0%
Case 20	-4%	-10%	10%	20%	-4%	3%
Case 21	-12%	-20%	20%	40%	-8%	6%
Case 22	-22%	-30%	30%	60%	-12%	9%

Results



Observed reductions due to the combined effect of technical (efficiency) improvements and increase in utility factor

Impact assesment M1 on projection scenarios WEM - WAM

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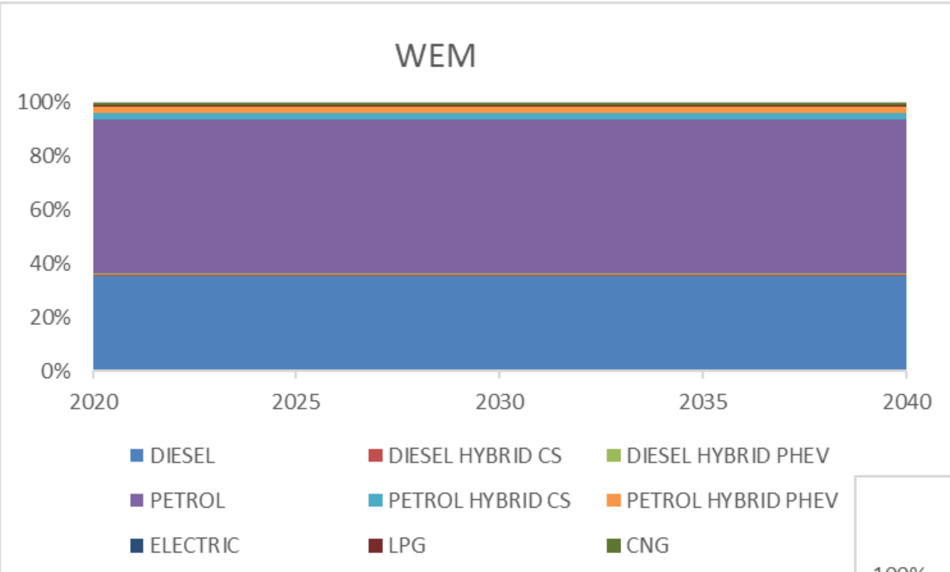
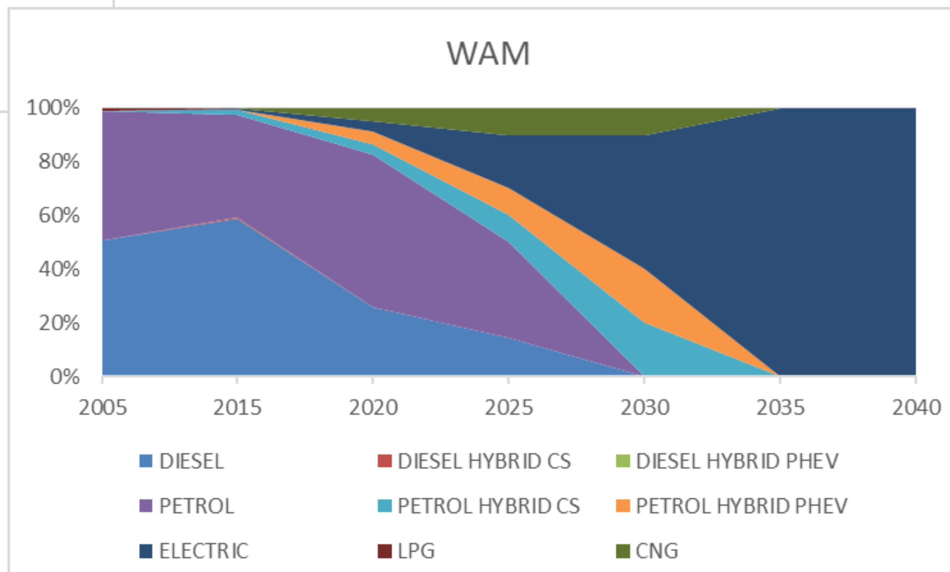
Assumptions – New Fleet

- Fuel technology distribution for the new fleet





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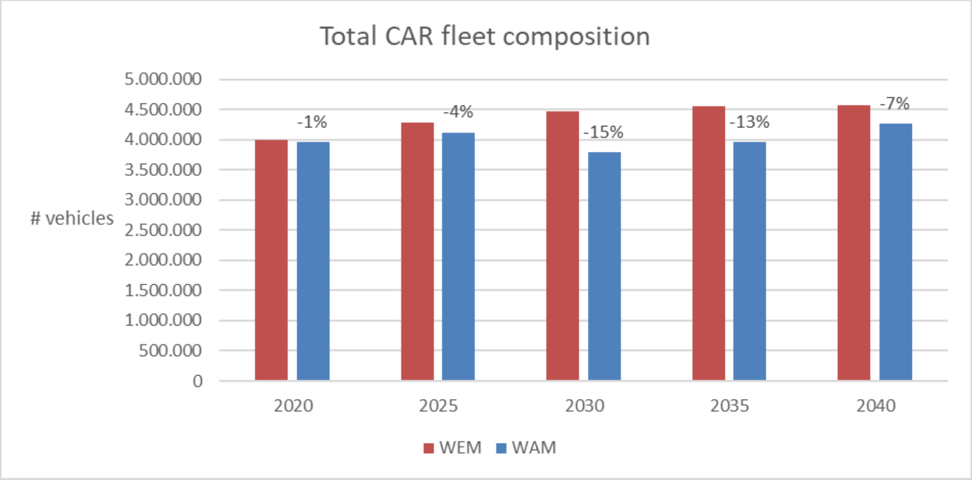
Assumptions

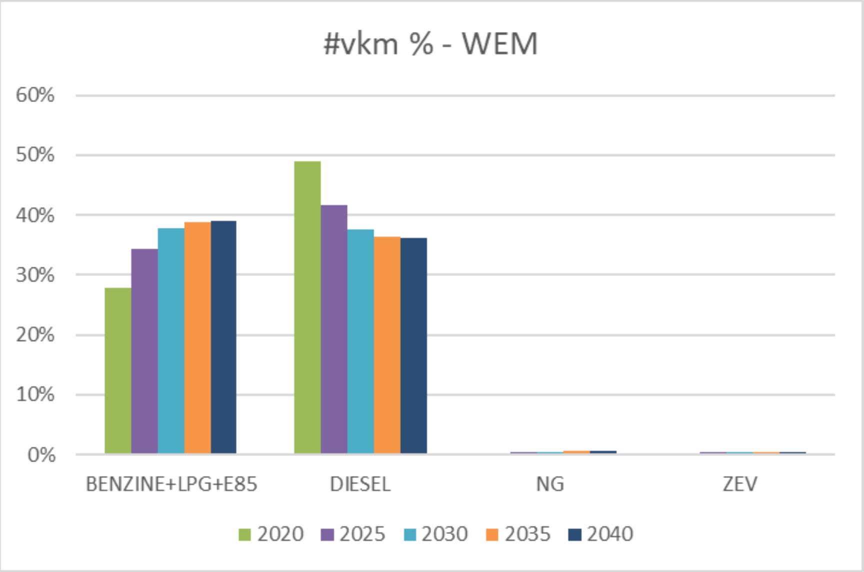
- Different mobility
  WEM → normal grow vkms
  WAM → lower grow vkms

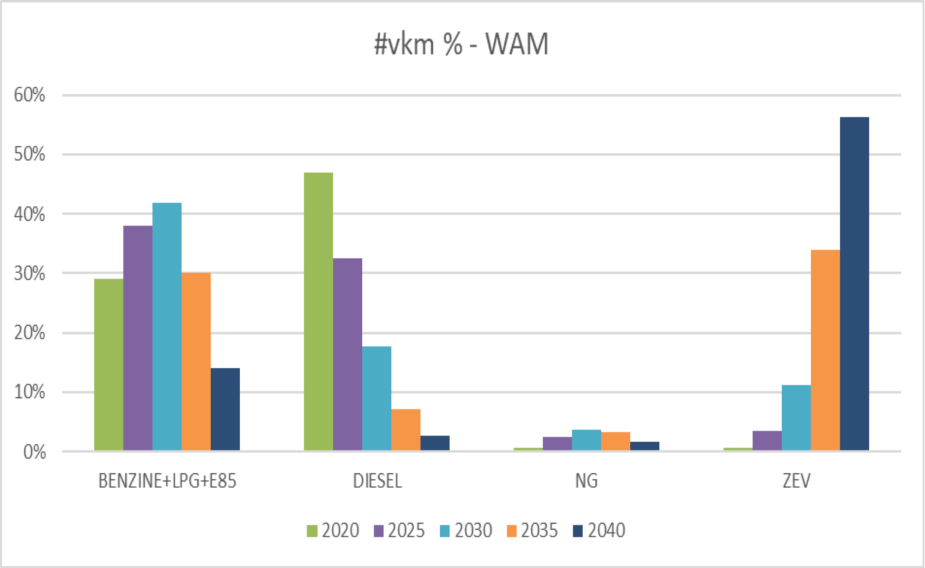


- Initial analysis was based on COPERT version 4
  → Presented→ Cumulative effect from COPERT 5.3 (EF for conventional and hybrid CS cars) and new EF from PHEV (upcoming in COPERT 5)

Assumptions

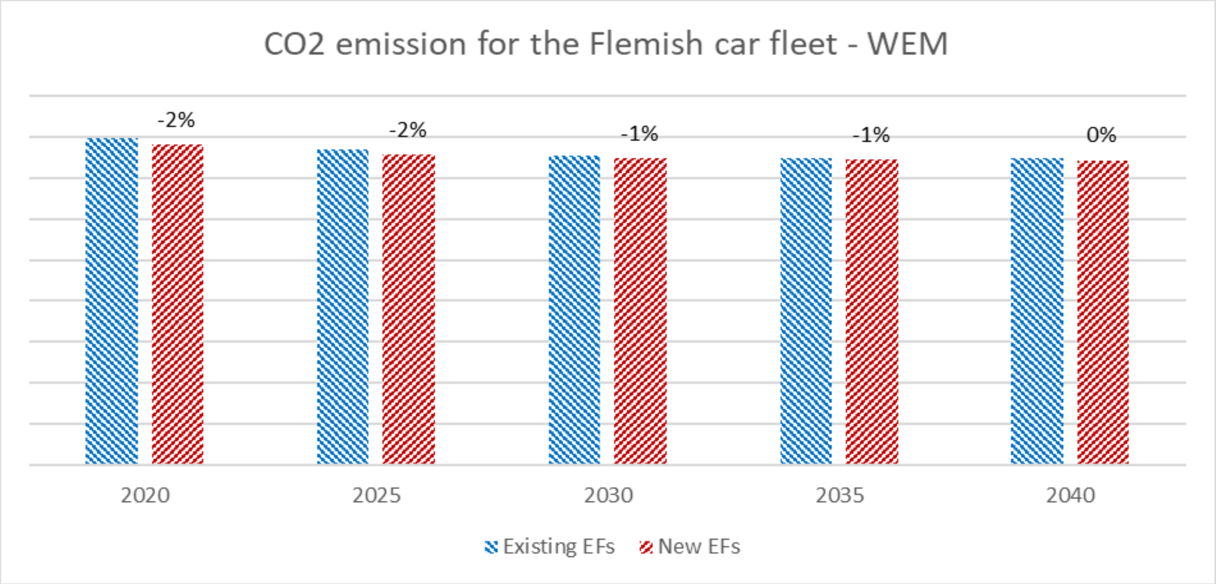
- Total fleet - fuel technology distribution

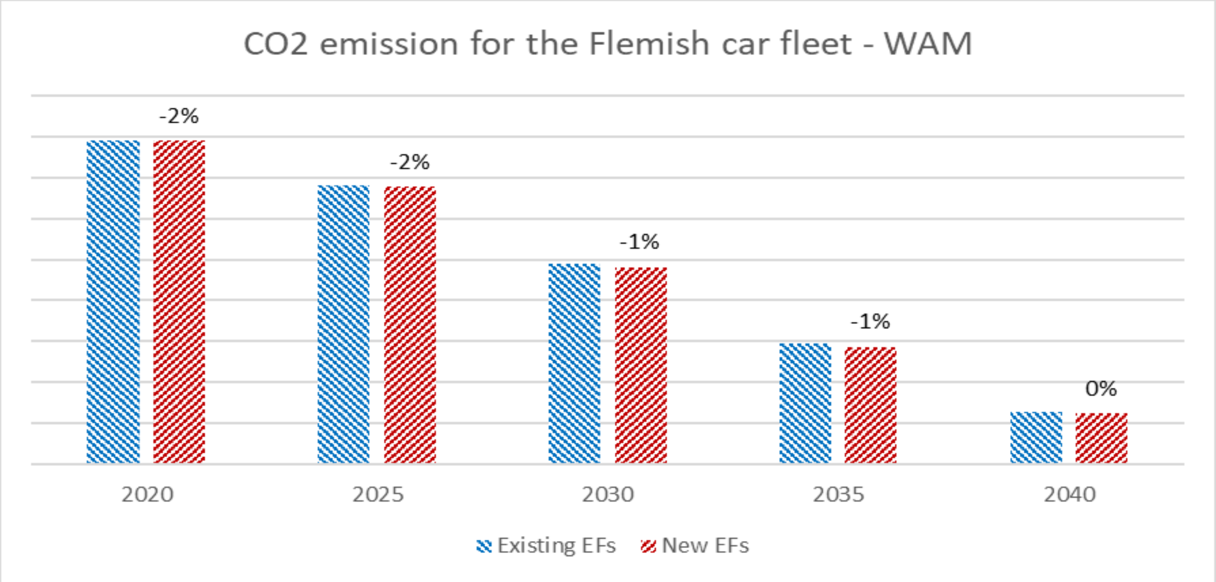




Impact on CO_2 emission

- WEM
- WAM





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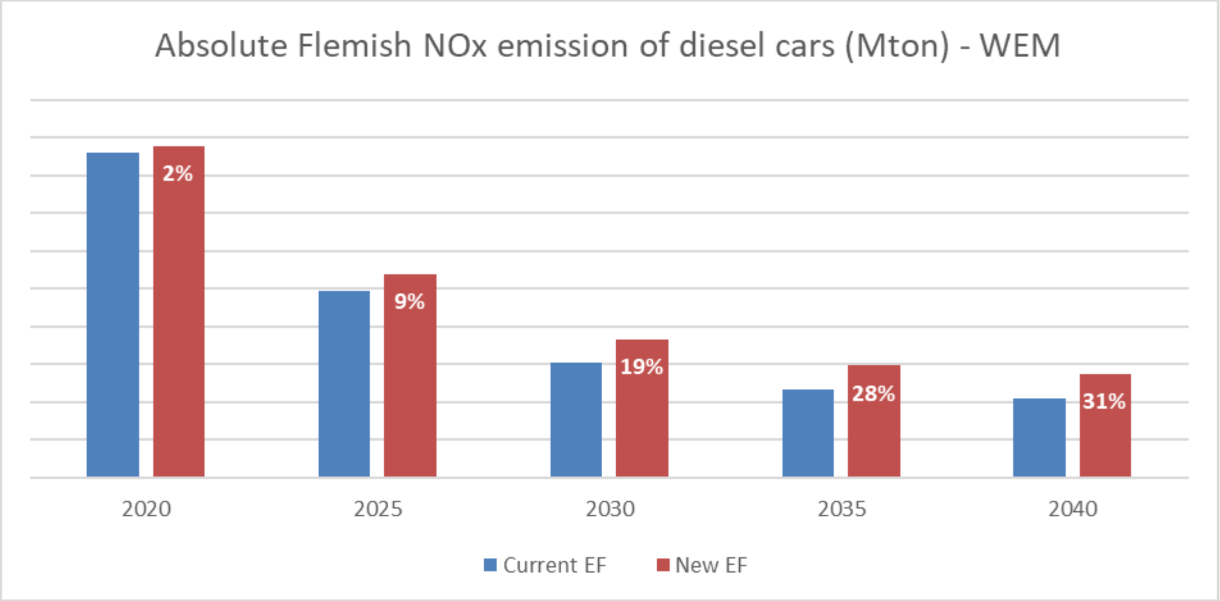
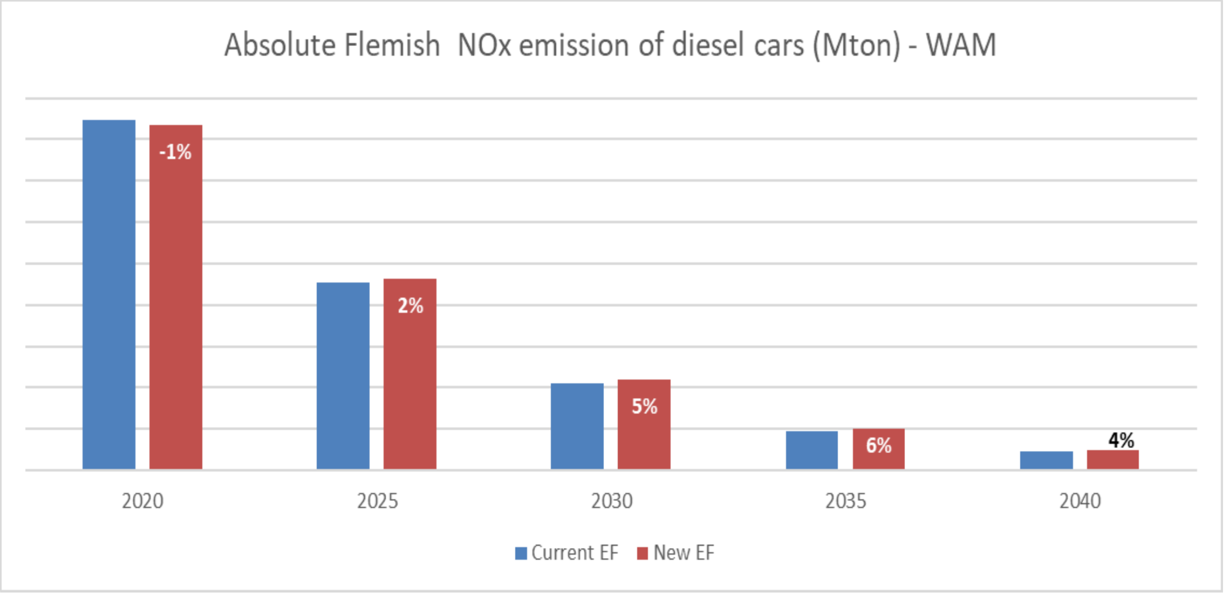
Impact on NOx emissions

- WEM



- WAM



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Explanation of NOx diesel impact

NOx (g/km)		Current Efs based on COPERT 4.11			New Efs based on COPERT 5.3			Rel. %		
		Urban	Rural	Highway	Urban	Rural	Highway	Urban	Rural	Highway
Diesel small	**Euro 6 <2017**	0,649	0,423	0,505	0,563	0,422	0,505	-13%	0%	0%
	Euro 6 2017-19	0,214	0,140	0,167	0,430	0,323	0,386	101%	131%	132%
	Euro 6 2020+	0,153	0,100	0,119	0,209	0,157	0,187	36%	57%	57%
Diesel medium	**Euro 6 <2017**	0,649	0,423	0,505	0,563	0,422	0,505	-13%	0%	0%
	Euro 6 2017-19	0,214	0,140	0,167	0,430	0,323	0,386	101%	131%	132%
	Euro 6 2020+	0,153	0,100	0,119	0,209	0,157	0,187	36%	57%	57%
Diesel large	**Euro 6 <2017**	0,649	0,423	0,505	0,563	0,422	0,505	-13%	0%	0%
	Euro 6 2017-19	0,214	0,140	0,167	0,430	0,323	0,386	101%	131%	132%
	Euro 6 2020+	0,153	0,100	0,119	0,209	0,157	0,187	36%	57%	57%
	Euro 5	0,788	0,514	0,613	0,683	0,513	0,613	-13%	0%	0%

Upgrade in COPERT 5 for Euro 6 (2017/2020 and 2020+) conventional diesel cars

Conclusions impact analysis of new EF on CAR Fleet scenarios

- For CO_2-emissions
  → No major impact on WEM and WAM scenario

- For NOx-emissions
  → Major impact on WEM because of higher EF of conventional diesel cars Euro 6 (2017 and up) in COPERT 5.3
    × Negative impact on local air quality!

  → Impact increases in the WEM scenario in time because of introduction of Euro 6 diesel cars (2017/2019 and 2020+) in the fleet

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General conclusions

Plug-in hybrids

- Are stimulated by the European Commission
  - → In order of to achieve the climate and air quality goals
- Potentially sustainable way-maker for EVs
  - → Depends heavily on state-of-charge and how the vehicle is driven
  - → Difficult for governments to control this -> measurements!
- No incentives for OEMs to make better PHEVs
  - → Small engines + large batteries are OUT
  - → Large engines + small batteries are IN
  - → Scenarios for future PHEV presented, but which case will become reality?
- Future for PHEVs depend on local measures (2030-35 vision)
  - → Incentives + infrastructure

Plug-in hybrids

- LCV & HDV
  - → LCVs to follow cat M1 market?
  - → HDVs to pick 'lower-hanging' fruits before electrifying

Thanks to the research team :

Hooftman N. (VUB), Ligterink N. (TNO), Paalvast M. (TNO), van Gijlswijk R. (TNO), Voogd E. (TNO), Mellios G. (EMISIA), Samos Z. (EMISIA), Mamarikas S. (EMISIA), Kapetanios N. (EMISIA) and Verhoeve W. (EMISIA)

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