TFTEI

Under the Convention on Long Range Transboundary Air Pollution

Review of the technical annexes of the Gothenburg Protocol

TFTEI technical secretariat
Irving Tapia (Citepa)

7th TFTEI Annual Meeting, October, 29th, 2021, VIRTUAL MEETING

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)

Road transport

- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)

Non-road Mobile Machinery

- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars

Railways

- Table 9: LV for engines for propulsion of inland waterways vessels
- Table 10: LV for engines in recreational crafts

- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Fuels

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)

Road transport

- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- Table 9: LV for engines for propulsion of inland waterways vessels
- Table 10: LV for engines in recreational crafts
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Road Transport (PC, LDV & HDV)

- Table 1: Limit values for passenger cars and light-duty vehicles
- Table 2: Limit values for heavy-duty vehicles steady-state cycle load-response tests
- Table 3: Limit values for heavy-duty vehicles — transient cycle tests

2012 Amendment	Current Proposal	Other
Includes up to Euro 6/EURO VI No PM number for HDV	**To add to PC/LDV*:** - Euro 6b - Euro 6c - Euro 6d-TEMP - Euro 6d **Propose Euro 7?** **To add to HDV**:** - PM number (#/kWh) : 8.0 × 1011 (steady-state cycle load-response tests) 6.0 × 1011 (transient cycle tests) **Propose EURO VII?** **To add new categories:** - Electric Vehicles*** - Hybrid vehicles	• New effective retrofit technologies to reduce NOx emissions from diesel vehicles • New technologies to capture/filter particules from tyres. • Uncertainty/controversy regarding Euro 7/EURO VII

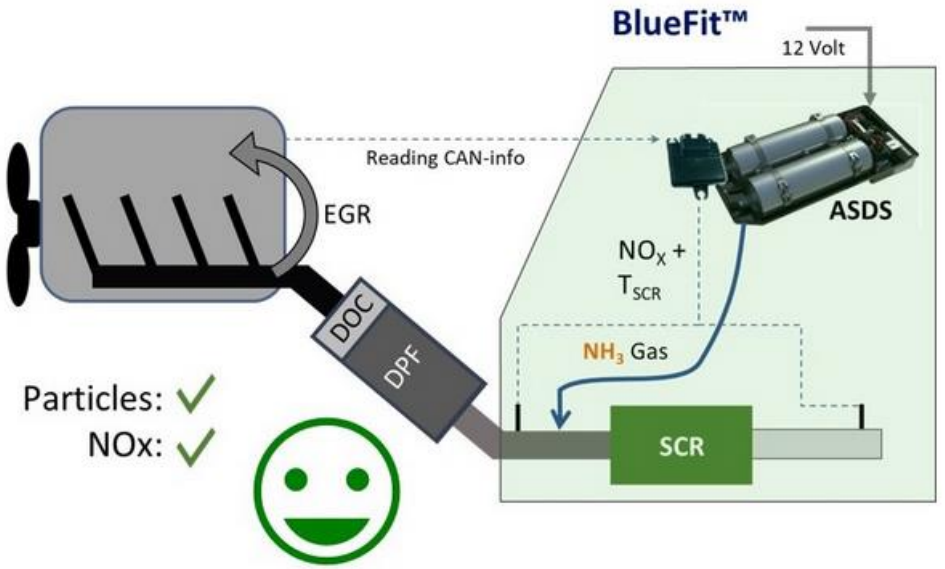
* To be in line with the COMMISSION REGULATION (EU) No 459/2012 of 29 May 2012 amending Regulation (EC) No 715/2007 of the European Parliament and of the Council and Commission Regulation (EC) No 692/2008 as regards emissions from light passenger and commercial vehicles (Euro 6)
** To be in line with the REGULATION (EC) No 595/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 June 2009 on type-approval of motor vehicles and engines with respect to emissions from heavy duty vehicles (Euro VI) and amending Regulation (EC) No 715/2007 and Directive 2007/46/EC and repealing Directives 80/1269/EEC, 2005/55/EC and 2005/78/EC
***Non-exhaust emissions

BAT : upgraded / new technologies

The Commission's 2018 Horizon Prize on Engine Retrofit for Clean Air demonstrated the effectiveness and relatively low costs of retrofitting. It spurred the development of new technologies that can be applied to recent EURO 5 and EURO 6 diesel engines.

Retrofit Emissions Control systems → designed to reduce emissions levels for both older petrol and diesel vehicles.
https://retrofit4emissions.eu/

The BlueFitTM system, developed by Amminex is currently available for commercialization. It was the champion of the EU Horizon retrofit prize, whose IP rights have been recovered by the European Commission and are available for any interested company.



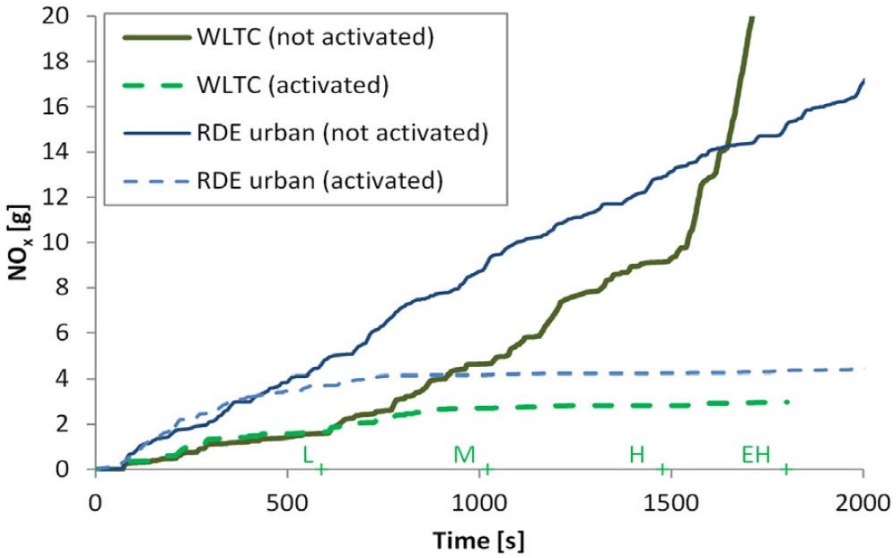
https://retrofit4emissions.eu/existing-systems/
https://ec.europa.eu/growth/content/study-retrofit-technologies%E2%80%99-potential-reduce-emissions-passenger-cars-and-light-commercial_en

BAT : upgraded / new technologies

Retrofit technology installed on a Euro 5 Diesel Passenger Car

In 2018 the European Commission awarded the Horizon Prize on Engine Retrofit for Clean Air to the winning consortia consisting of Amminex, Technical University Graz, Johnson Matthey PLC and ICCT.

The Horizon Prize recognizes the outstanding emissions reduction potential of the ASDS™ technology (Ammonia Storage and Delivery System) for retrofitting existing diesel vehicles.



- A Euro 5 diesel PC was retrofitted with the Ammonia Storage and Delivery System technology (ASDS™) combined with an SCR catalyst reducing NOx emissions to Euro 6 equivalent levels in real driving conditions.
- Average NOx emissions reduction from 865 mg/km to 150 mg/km
- ~3 km of urban driving (450 s) to reach the appropriate catalyst temperature for a considerable NOx reduction.
- Fuel penalty of only < 2%

https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/prizes/horizon-prizes/engine-retrofit_en
Press release, « Amminex receives European Commission Horizon prize for its denox retrofit solution », April 17, 2018, availavle at: https://www.faurecia.com/index.php/en/newsroom/amminex-receives-european-commission-horizon-prize-its-denox-retrofit-solution
*Giechaskiel, B.; Suarez-Bertoa, R.; Lahde, T.; Clairotte, M.; Carriero, M.; Bonnel, P.; Maggiore, M. Evaluation of NOx emissions of a retrofitted Euro 5 passenger car for the Horizon prize "Engine retrofit", Environmental Research 2018. https://doi.org/10.1016/j.envres.2018.06.006.

BAT : upgraded / new technologies

Retrofit technology installed on a Euro 5 Diesel Passenger Car

In 2018 the European Commission awarded the Horizon Prize on Engine Retrofit for Clean Air to the winning consortia consisting of Amminex, Technical University Graz, Johnson Matthey PLC and ICCT.

The Horizon Prize recognizes the outstanding emissions reduction potential of the ASDS™ technology (Ammonia Storage and Delivery System) for retrofitting existing diesel vehicles.

- Acquisition and **installation costs < 2K Euros**
- **Running costs ~ 200 Euros** for 100,000 km
- If combined with some level of cooperation with a manufacturer, **better cold start performance of the retrofitted vehicles could be achieved**.

Potential Applicability: "*Faurecia is actively developing the solution for the commercial vehicle market and has won contracts to retrofit a large number of urban buses in Copenhagen and London as well as fleets in Korea. With a track record of 50 million kilometers driven, it demonstrates that ASDS is a fast and cost-effective way to reduce NOx in cities and improve air quality*".

https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/prizes/horizon-prizes/engine-retrofit_en

Press release, « Amminex receives European Commission Horizon prize for its denox retrofit solution », April 17, 2018, availavle at: https://www.faurecia.com/index.php/en/newsroom/amminex-receives-european-commission-horizon-prize-its-denox-retrofit-solution

*Giechaskiel, B.; Suarez-Bertoa, R.; Lahde, T.; Clairotte, M.; Carriero, M.; Bonnel, P.; Maggiore, M. Evaluation of NOx emissions of a retrofitted Euro 5 passenger car for the Horizon prize "Engine retrofit", Environmental Research 2018. https://doi.org/10.1016/j.envres.2018.06.006.

BAT : upgraded / new technologies

Retrofit technology installed on a Euro 6b Diesel Passenger Car

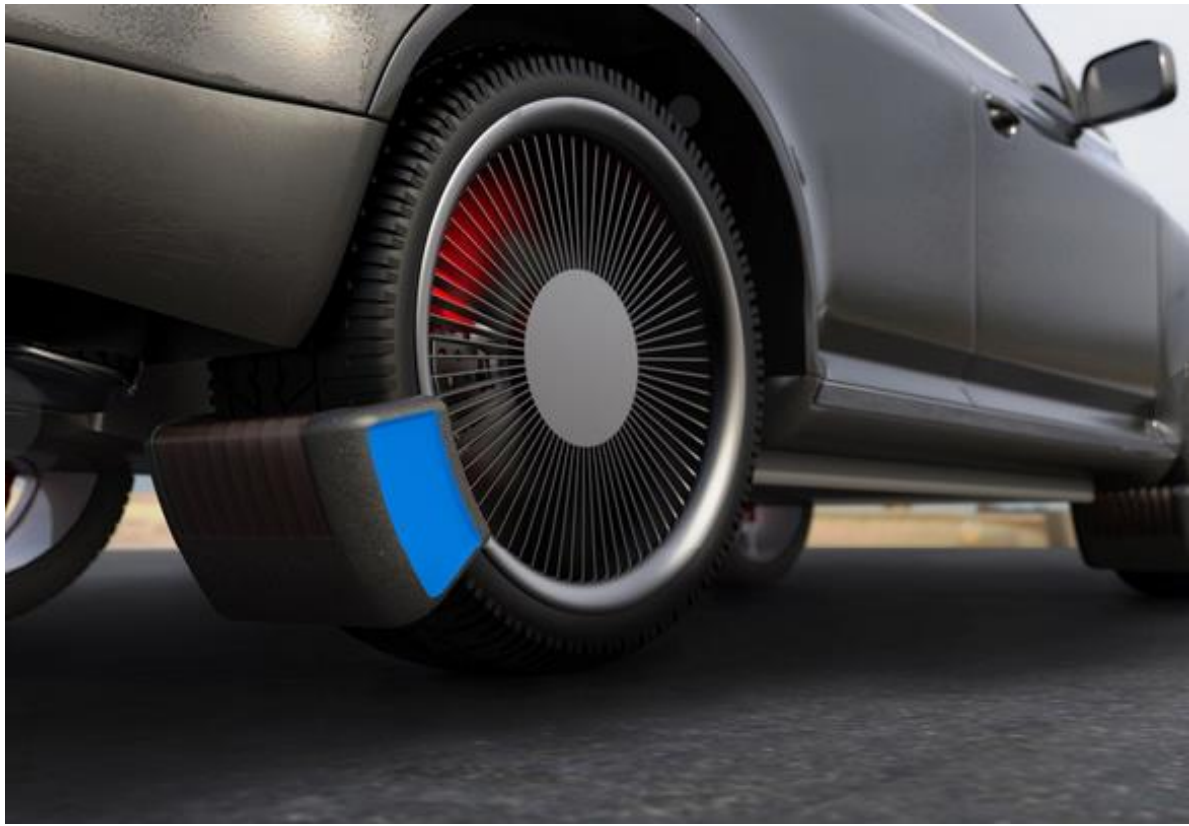
The retrofit consisted of an under-floor SCR for NOx catalyst in combination with a solid ammonia-based dosing system as the NOx reductant.

- **NOx reductions** of all cycles tested (Lab), on average, **from 570 mg/km to 200 mg/km.**
- The on-road (PEMS) **NOx reductions** ranging from **>1100 mg/km to 220–240 mg/km.**
- Reductions **without significant increase** of the FC and other pollutants (Particles, NH3 and N2O).
- NOx reductions at low ambient temperatures with cold start were negligible.
- N2O increase was negligible at cold start cycles, but up to 18 mg/km at hot start cycles.

*Giechaskiel, B.; Suarez-Bertoa, R.; Lahde, T.; Clairotte, M.; Carriero, M.; Bonnel, P.; Maggiore, M. Emissions of a Euro 6b Diesel Passenger Car Retrofitted with a Solid Ammonia Reduction System. *Atmosphere* **2019**, *10*, 180. https://doi.org/10.3390/atmos10040180

BAT : upgraded / new technologies

"**The Tyre Collective** aims to reduce this invisible pollution by capturing the tyre particles at the source. The team's device is fitted to the wheel and uses electrostatics to collect particles as they are emitted from the tyres, by taking advantage of various air flows around a spinning wheel. **The prototype can collect 60% of all airborne particles from tyres**, under a controlled environment on their test rig"



https://newseu.cgtn.com/news/2020-09-18/Why-electric-cars-won-t-end-pollution-from-vehicles-TREQ6XDdq8/index.html
https://www.thetyrecollective.com/
https://www.dyson.co.uk/newsroom/overview/features/september-2020/jda-national-winnner-announcement

BAT : upgraded / new technologies

tallano technologie

- All means of transport are concerned by the release of fine particles into the air during braking, including electric vehicles. The particle capture solution developed by Tallano Technologie is scalable and adaptable to:

  - ✓ small city cars
  - ✓ sedan
  - ✓ truck
  - ✓ bus
  - ✓ railways

- The vacuum system is lightweight and self-contained, and does not affect vehicle performance.

- Tamic® reduces particle emissions during braking by more than 90%. Most of these particles are retained by the Tamic® system, whose filters must be changed every two years (or every 30,000 km). These are then recycled.

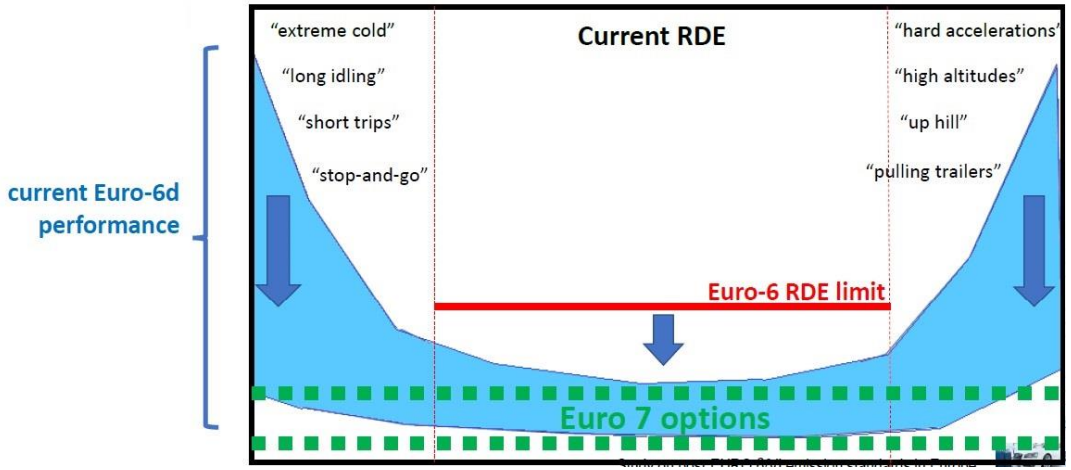
https://www.tallano.eu/en/tamic-automobile/
https://www.tallano.eu/en/tamic-ferroviaire/

Euro 7/VII emission limits scenarios

Euro 7/VII emission limits scenarios

Stringent emission limit values for **Passenger cars**

- **Euro 7/VII limits lower than current limits, compatible with today's BATs***



*CLOVE: Consortium for ultra Low Vehicle Emissions

CLOVE's* Petrol Passenger Cars Euro 7 LV*

	NOx [mg/km]	CO [mg/km]	PN [#/km]
EU6d (ext + CF)	137	2400	1.4E+12
EU6d delete CF	96	1600	9.6E+11
EU6d minus ext factor	60	1000	6.0E+11
Propose limit	30	300	1.0E+11
PN10 (assume factor 1.4)			7.1E+10
5km	9,4	93.8	2.2E+10
Ratio	0.068	0.039	0.016
Effective reduction EU6d to Euro 7	**93%**	**96%**	**98%**

Disadvantages : Lack of LV proposal for heavier N1 vehicles (class II & III)**

Sources:
*Zissis Samaras, S. Hausberger, G. Mellios, 2020. Preliminary findings on possible Euro 7 emission limits for LD and HD vehicles, available at: https://circabc.europa.eu
**ACEA Position Paper: Views on proposals for Euro 7 emission standard – December 2020.pdf, available at: https://www.acea.auto/publication/position-paper-views-on-proposals-for-potential-euro-7-emission-standard/

Euro 7/VII emission limits scenarios

Proposed emission limit values for **Light-duty vehicles**

CLOVE's* Euro 7 emission limits scenarios for Light-duty vehicles in mg/km, #/km

Euro 7 scenarios	NOx	SPN_{10}	CO	CH_4 (1)	N_2O (1)	NH_3
EURO 6	60/80 (PI/CI)	6×10^{11} (SPN_{23})	1000/500 (PI/CI)	-	-	-
A	**30**	**1×10^{11}**	**300**	**10**	**10**	**5**
B	**10**	**6×10^{10}**	**100**	**5**	**5**	**2**

(1) Suggested to limit weighted sum of CH4 and N20 instead of separate limits

***CLOVE**: Consortium for ultra Low Vehicle Emissions →

Source: Zissis Samaras, S. Hausberger, G. Mellios, 2020. Preliminary findings on possible Euro 7 emission limits for LD and HD vehicles, available at: https://circabc.europa.eu

Euro 7/VII emission limits scenarios

Proposed emission limit values for **Heavy-duty vehicles**

CLOVE's* Euro 7 emission limits scenarios for Heavy-duty vehicles in mg/kWh, #/kWh

Euro 7 scenarios	NOx	SPN_{10}	CO	CH_4 (1)	N_2O (1)	NMHC	NH_3
EURO VI	460	6×10^{11} (SPN_{23})	4000	500 (PI)	-	160 (CI, THC)	10ppm ~40 mg/kWh]
A	**120**	**4×10^{11}**	**1500**	**100**	**50**	**50**	**20**
B	**40**	**1×10^{11}**	**400**	**50**	**25**	**25** (2)	**10**

(1) Suggested to limit weighted sum of CH4 and N20 instead of separate limits

***CLOVE**: Consortium for ultra Low Vehicle Emissions →

Source: Zissis Samaras, S. Hausberger, G. Mellios, 2020. Preliminary findings on possible Euro 7 emission limits for LD and HD vehicles, available at: https://circabc.europa.eu

Ongoing debate regarding Euro 7/VII emission limits scenarios

Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ACEA*, CLOVE's ELV
EXTREMELY STRINGENT AND NOT FEASIBLE :

All vehicle categories

"*a complete and serious revision of the scenarios presented by CLOVE has to be made because industry planning decisions for what happens 10 and more years away are being taken now*" .

PC

Regarding proposed reduction technologies for Euro 7 (gasoline) : "*not realistic installation proposition, especially for small-sized vehicles*"

LCV & HDV

"*Extremely stringent emission limits for light duty vehicles. Coupled with open-RDE testing, neither Scenario B or A have any potential for technical feasibility or cost-effectiveness*."

*ACEA: European Automobile Manufacturers' Association

ACEA Position Paper: Views on proposals for Euro 7 emission standard – December 2020 available at: https://www.acea.auto/publication/position-paper-views-on-proposals-for-potential-euro-7-emission-standard/

Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ICCT*, CLOVE's ELV NOT STRINGENT ENOUGH :

Light-duty vehicles :

Regarding the emissions budget in urban operation

- *"The current CLOVE proposal suggests an emission budget based on 16 km, when typical urban trips in European cities can be significantly shorter"* →

  - ✓ *"To ensure Euro 7 delivers low emission in conditions typical of European cities, ICCT suggests shortening the emission budget to a maximum distance of 8 km, adjusting the budget limit accordingly, and recognizing the disproportionate impact of cold-start emissions in such operations".*

*ICCT, May 7, 2021, « ICCT'S comments and technical recommendations on future Euro 7/VII emission standards », available at https://theicct.org/news/eu-commission-euro-7-and-VI-may2021

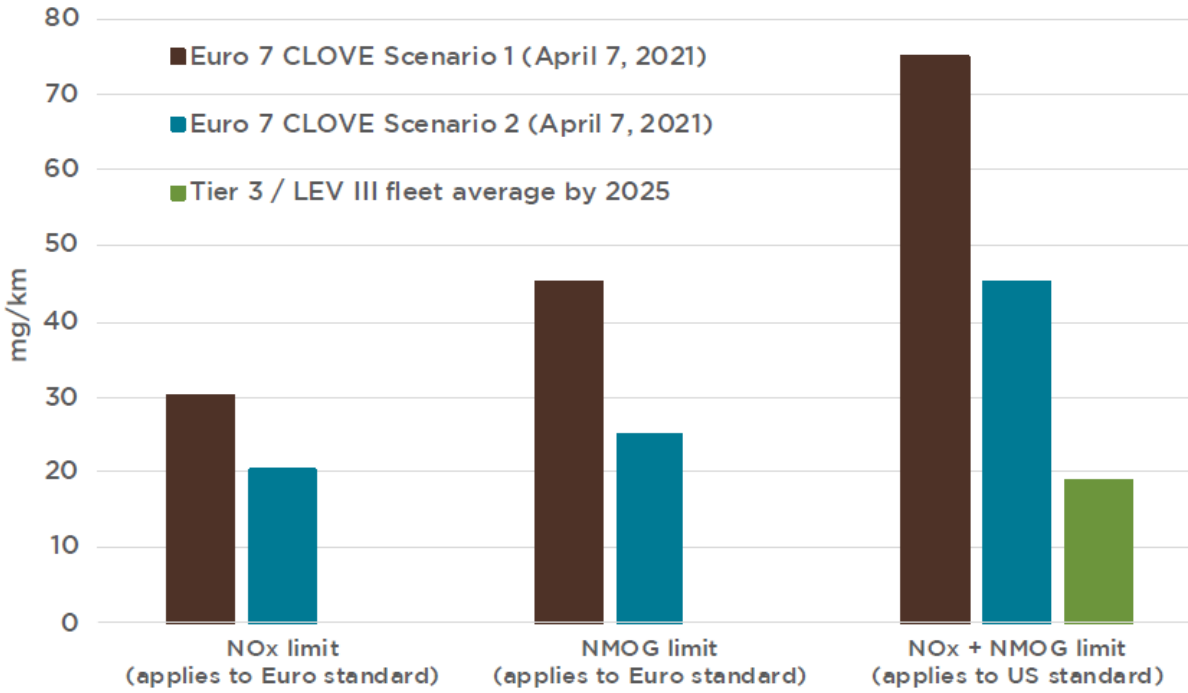
Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ICCT*, CLOVE's ELV NOT STRINGENT ENOUGH :

Light-duty vehicles :

Regarding technology feasibility for more stringent limits than proposed by CLOVE →

"Even the most stringent CLOVE scenario 2 (NOx limit of 20 mg/km) would lead to a higher limit than in the US for NOx and NMOG combined (18.6 mg/km)".



*ICCT, May 7, 2021, « ICCT'S comments and technical recommendations on future Euro 7/VII emission standards », available at https://theicct.org/news/eu-commission-euro-7-and-VI-may2021

Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ICCT*, CLOVE's ELV NOT STRINGENT ENOUGH :

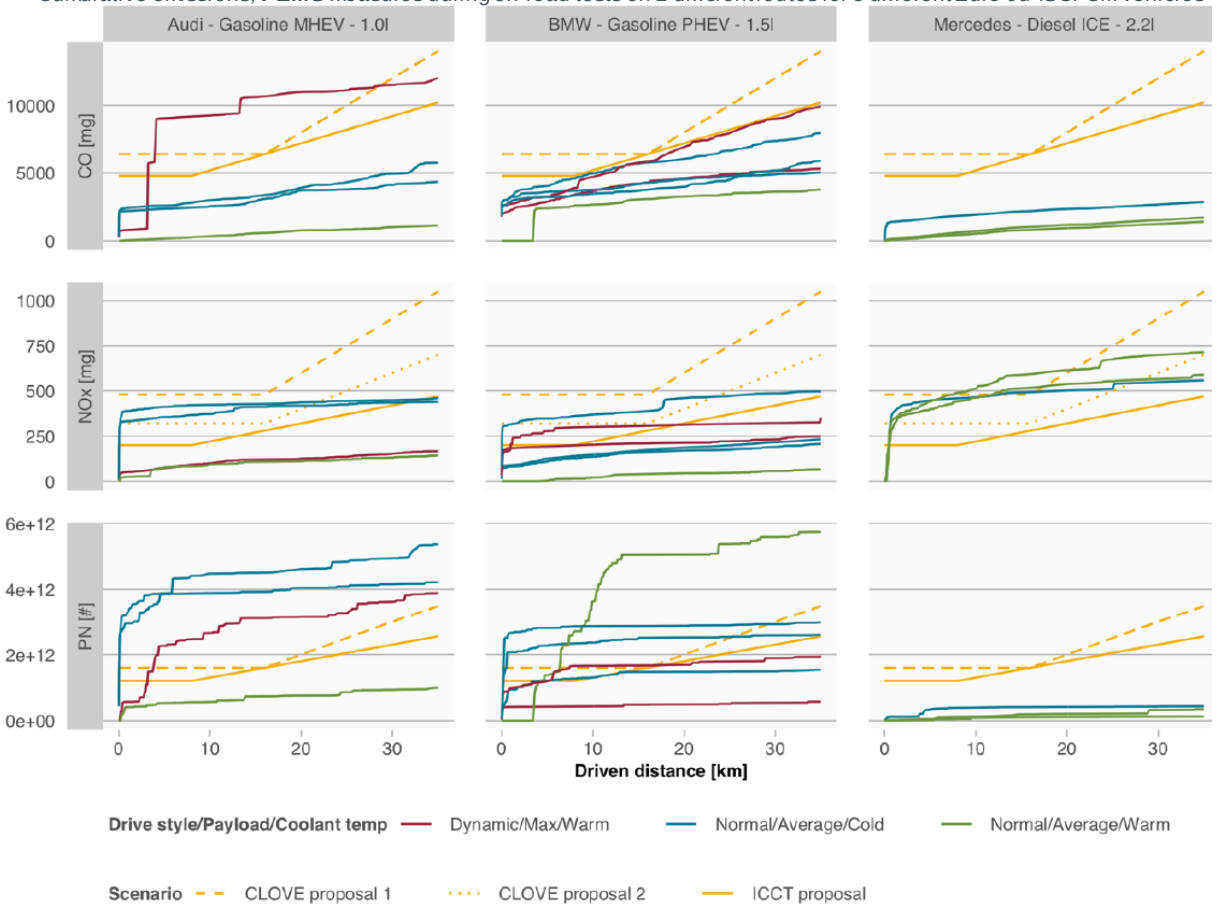
Light-duty vehicles :

3 Euro 6d vehicle

PEMS tests

- *For CO and NOx CLOVE-scenario-1 emission limits = Euro 6d technology vehicles.*
- *Modern diesel and gasoline engines are almost fit to meet the CLOVE1 limits and therefore a more ambitious target is reasonable.*
- *The majority of the emissions is generated over the first few kilometers and therefore a shorter range for the emission budget than 16 km seems justified.*

*Cumulative emissions, **PEMS** measures during on-road tests on 2 different routes for 3 different Euro 6d-ISCFCM vehicles*



*ICCT, May 7, 2021, « ICCT'S comments and technical recommendations on future Euro 7/VII emission standards », available at https://theicct.org/news/eu-commission-euro-7-and-VI-may2021

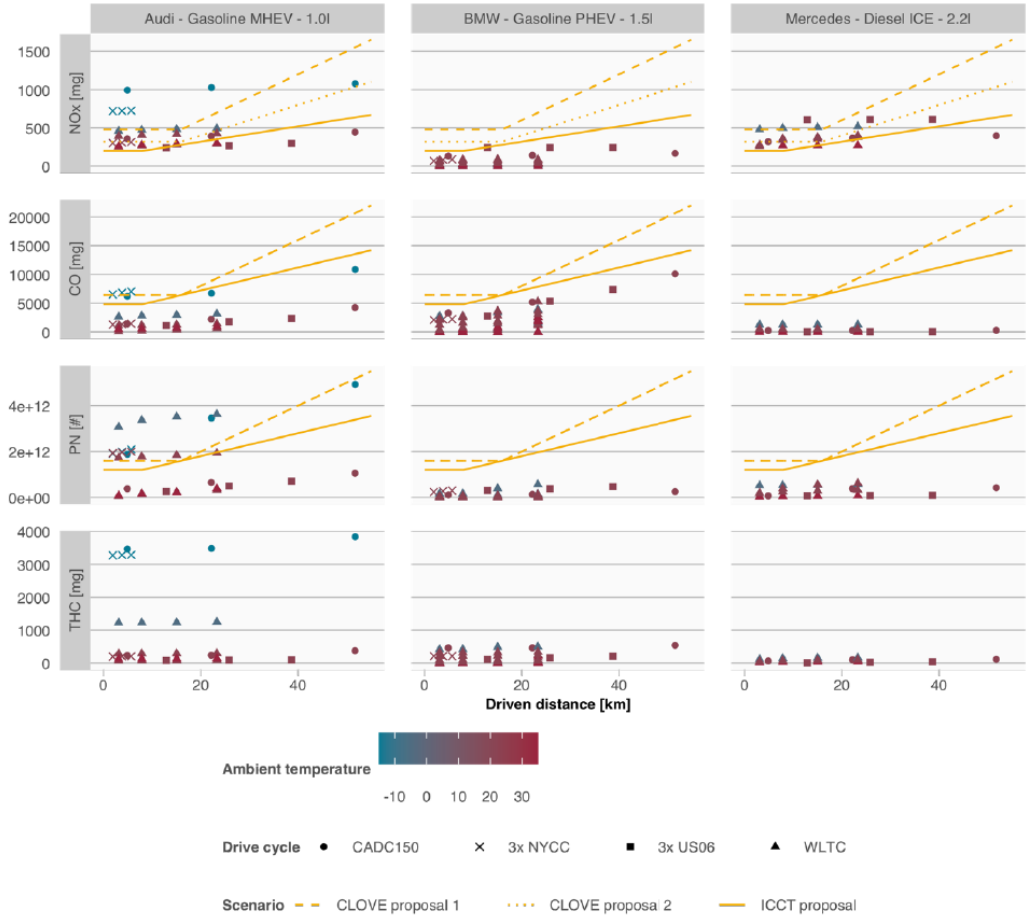
Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ICCT*, CLOVE's ELV NOT STRINGENT ENOUGH :

Light-duty vehicles :

3 Euro 6d vehicle lab tests

- *Similarly to the on-road observations, the CO and NOx results for all tests in an ambient temperature range of -5 to 23 °C are within or close to the CLOVE-scenario-1 limits.*
- *The chassis dyno results confirm that the CLOVE-scenario-1 limits are close to the emission levels that can be achieved with latest Euro 6d technology today.*
- *More ambitious limits are justifiable to pull new emission control technologies to the market that goes beyond the current technology adoption.*



*ICCT, May 7, 2021, « ICCT'S comments and technical recommendations on future Euro 7/VII emission standards », available at https://theicct.org/news/eu-commission-euro-7-and-VI-may2021

Ongoing debate regarding Euro 7/VII emission limits scenarios

According to ICCT*, CLOVE's ELV NOT STRINGENT ENOUGH :

Heavy Duty Vehicles :

- The ICCT urges the Commission to set more stringent limits for NH_3 and N_2O than those proposed by CLOVE in hot operation.
- The focus should be placed in setting the 100th and 90th percentile limits at the level of what is technically feasible with future technologies, and not at what the best performing Euro VI vehicles can achieve.

The Southwest Research Institute (SwRI) and the Association for Emissions Control by Catalys (AECC) demonstrated that

- ✓ current technologies could reach significantly lower levels than the NOx limits proposed by CLOVE.
- ✓ Meeting the proposed CLOVE NOx limits is feasible, even without a full technology deployment!

*ICCT, May 7, 2021, « ICCT'S comments and technical recommendations on future Euro 7/VII emission standards », available at https://theicct.org/news/eu-commission-euro-7-and-VI-may2021

Road Transport (motorcycles & mopeds)

- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)

2012 Amendment	Current Proposal	Other
Includes only 2 categories (> 50 cm3; > 45 km/h) and (<50 cm3; < 45 km/h) Not updated ELV	✓ Update according to the REGULATION (EU) No 168/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles. ✓ Euro 5 mandatory as of 01/01/2021 **<u>To add new categories:</u>** • Electric motorcycles*	• Retrofit technologies to reduce NOx emissions • Other BATs

*Non-exhaust emissions

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)
- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- Table 9: LV for engines for propulsion of inland waterways vessels
- Table 10: LV for engines in recreational crafts
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Non-road Mobile Machinery

Non-road Mobile Machinery

- Table 4 : Limit values for diesel engines for non-road mobile machines, agricultural and forestry tractors (stage IIIB)
- Table 5 : Limit values for diesel engines for non-road mobile machines, agricultural and forestry tractors (stage IV)
- Table 6 : Limit values for spark-ignition engines for non-road mobile machines

2012 Amendment	Current Proposal	Other
Stage IIIB (Table 4) Stage IV (Table 5)	✓ Update according to REGULATION (EU) 2016/1628 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC. - Stage V - Add « PN#/kWh » to Limit values for diesel engines for NRMM, agricultural and forestry tractors **<u>To add new categories:</u>** • Electric NRMM*	• Other BATs

*Non-exhaust emissions

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)
- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- Table 9: LV for engines for propulsion of inland waterways vessels
- Table 10: LV for engines in recreational crafts
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Railways

Railways

- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars

2012 Amendment	Current Proposal	Other
ERROR detected! tables are inverted!! Railcars RLR >< Locomotives RLL	✓ Update according to REGULATION (EU) 2016/1628 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC. - Invert tables (correct error from left column) - RLL (locomotives): Table II-7: Stage V, page 64 - RLR (Railcars): Table II-8: Stage V, page 64	• ELV for abrasion*? : from catenaries, train braking and rails/tracks → PM, Heavy metals** • Other BATs

*Non-exhaust emissions
** https://uic.org/, possible early stage of research

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)
- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- **Table 9: LV for engines for propulsion of inland waterways vessels**
- Table 10: LV for engines in recreational crafts
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Inland waterways

- Table 9: LV for engines for propulsion of inland waterways vessels

2012 Amendment	Current Proposal	Other
Stage III A (There are no Stage III B or Stage IV standards for waterway vessels) Only limit values for engines for propulsion of inland waterways vessels (not IWA).	✓ Update according to REGULATION (EU) 2016/1628 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC. - Include IWA (auxiliary engines) - Stage V	• NOx reduction techniques: EGR and SCR. • Diesel particulate filters (DPF) • Switching to electric or hybrid engines: - Electric / hydrogen (H). - Electric / Non-road diesel (NRG) • Alternative fuels: - GTL: (Gas-to-Liquid) - LNG (Liquefied Natural Gas) - CNG (Compressed Natural Gas) - HVO (Hydrotreated Vegetable Oil) • Other BATs

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)
- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- Table 9: LV for engines for propulsion of inland waterways vessels
- **Table 10: LV for engines in recreational crafts**
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Recreational crafts

- Table 10: LV for engines in recreational crafts

2012 Amendment	Current Proposal	Other
1 table for ELV by Engine type (2-stroke 4-stroke and CI)	✓ Update according to DIRECTIVE 2013/53/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC - Add more detailed ELV (in termes of Rated Engine Power) * Exhaust emission limits for compression ignition (CI) engines * Exhaust emission limits for spark ignition (SI) engines	• NOx reduction techniques: EGR and SCR ? • Diesel particulate filters (DPF) • Switching to electric or hybrid engines: - Electric / hydrogen (H). - Electric / Non-road diesel (NRG) • Other BATs/alternative fuels

Quick overview of the tables under review (Annex VIII)

- Table 1: LV for PC & LDV(Petrol & Diesel)
- Table 2: LV for HDV steady-state cycle load-response tests
- Table 3: LV for HDV — transient cycle tests
- Table 11: LV for motorcycles (> 50 cm3; > 45 km/h)
- Table 12: LV for mopeds (<50 cm3; < 45 km/h)
- Table 4 & 5: LV for diesel engines for NRMM, agricultural and forestry tractors
- Table 6: LV for spark-ignition engines for NRMM (petrol)
- Table 7: LV for engines used for propulsion of locomotives
- Table 8: LV for engines used for propulsion of railcars
- Table 9: LV for engines for propulsion of inland waterways vessels
- Table 10: LV for engines in recreational crafts
- Table 13: Environmental specifications for marketed fuels to be used for vehicles equipped with positive-ignition engines (Petrol)
- Table 14: Environmental specifications for marketed fuels to be used for vehicles equipped with compression-ignition engines (Diesel)

Fuels

Thank you very much for your attention! Questions?

TFTEI Technical Secretariat