Evaluation of future new policies on noise emissions

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17 Feb 2025 (after the meeting)

*Leon-T **external** presentation*

Overview

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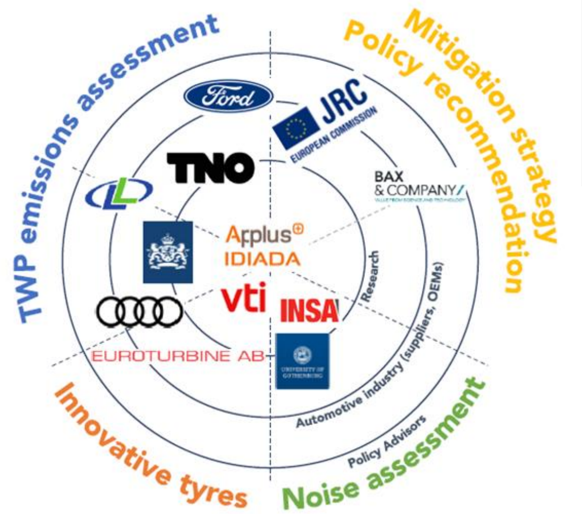
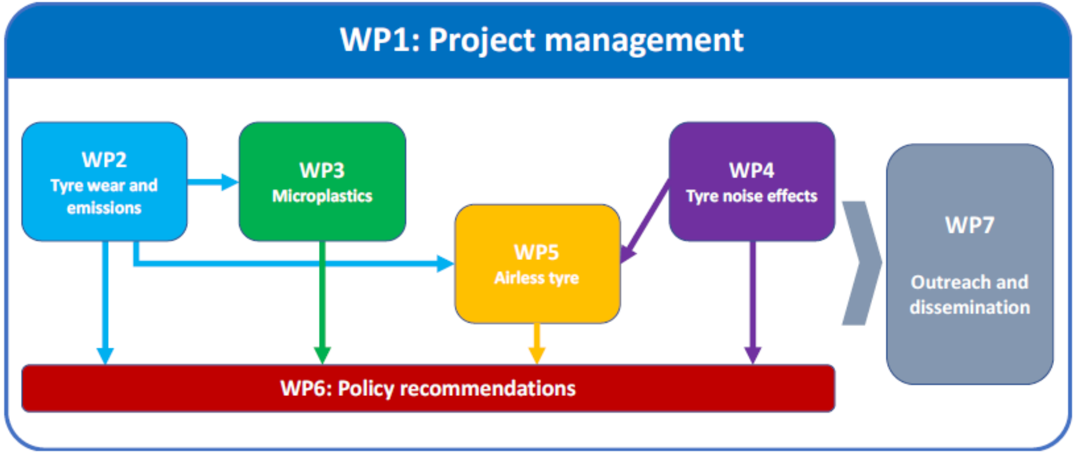
- About Leon-T
- Correlation of tyre parameters
  - Labelling parameters
  - Consumers data
- Propulsion engines data
- Noise calculation tool
  - Methodology
  - Results
- Conclusions and future considerations

Low particle Emissions and lOw Noise Tyres

- Call / Topic / Project:
  H2020-MG-2020-TwoStages / LC-MG-1-14-2020 / 955387 (LEON-T)
- Duration: June 2021 until June 2024 (extension until Nov 2024)
- www.leont-Project.eu/the-Project/
- WP1: Project management
- **WP2: Tyre wear and emissions**
- **WP3: Microplastics**
- **WP4: Tyre noise effects**
- **WP5: Airless tyre**
- **WP6: Policy recommendations**
- WP7: Outreach and dissemination





WP6: Overview

Tasks

- **Task 6.1** – Definition of possible future policy scenarios regarding tyre wear **particle emissions**. Cost benefit analysis and evaluation of their impact to the public health and well-being of citizens (Leader: JRC)
- **Task 6.2** – Definition of possible future policy scenarios regarding **microplastics emissions** from tyres. Cost benefit analysis and evaluation of their impact to the public health and well-being of citizens (Leader: JRC)
- **Task 6.3** – Definition of possible future policy scenarios regarding **noise emissions**. Cost benefit analysis and evaluation of their impact to the public health and well-being of citizens (Leader: JRC)

Study on label parameters (EPREL)

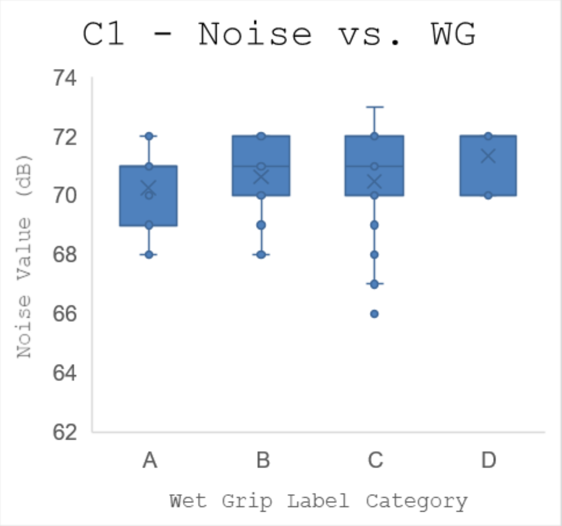
Five best-selling sizes ×30 tyres (representation of market brands) for each type of tyre (C1, C2 and C3) (450 tyres in total)

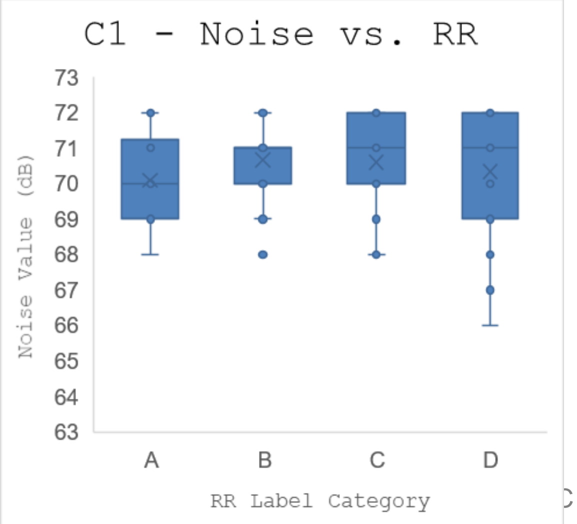
	Dimensions	Brand	Model	Identifier	Winter	Std / Reinf.
1	205/55R16	Continental	EcoContact 6	314991	No	Std
2	205/55R16	Lassa	REVOLA	218004AP	No	Reinf.
8	205/55R16	Giti Tire	GitiSynergy H2	A4893H	No	Reinf.
3	205/55R16	Apollo	Alnac 4G	8714692998621	No	Std
4	205/55R16	Admiral	RCB008	P00-3220018186	No	Std

Average Max – Ave (db)		
C1	C2	C3
1.5	1.3	2.9

RR	WG	Noise (dB)	Price (€)	Budget
A	B	71	89.5	Premium
B	A	71		Mid Range
C	A	72		Mid Range
B	B	69		Mid Range
D	C	71		Mid Range

Tendency of lower noise with *lower* letter of (=improved) rolling resistance (RR) for C1, C2 and C3 tyres. For WG there was no correlation (C2, C3) or lower noise with *lower* letter (C1).





Study on label parameters

For each tyre size (e.g. 205/55R16 winter or summer) correlation with one parameter was attempted.

- For C1: With decreasing RR letter (better performance), noise increases (negative impact). With decreasing WG letter, noise decreases (positive impact).
- For C2: With decreasing RR letter (better performance), noise decreases (positive impact). With decreasing WG letter, noise decreases (positive impact).
- For C3: With decreasing RR letter (better performance), noise decreases (positive impact). With decreasing WG letter, noise decreases (positive impact).

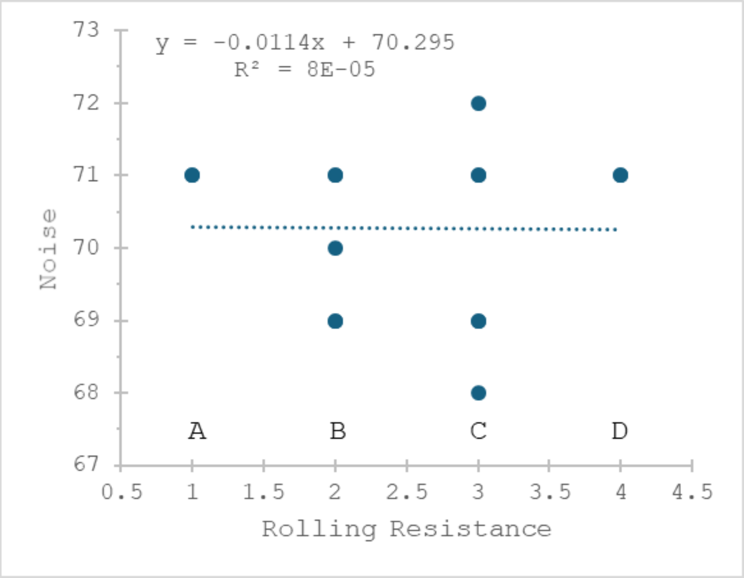


Table 13 : Relation of RR category and noise levels for season and sizes of C1 tyres.

Size	Winter	RR category	Sample size	Average Noise (dB)	Average Price (€)
205/55R16	No	A	2	71.00	86.50
		B	5	70.00	91.67
		C	6	70.00	97.99
		D	2	71.00	-
	Yes	B	5	70.80	96.50
		C	7	71.14	116.33
		D	3	69.33	93.50

Study on label parameters

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- Keeping RR and WG the same letter (constant) and correlating noise with tyre price the following trends were found:
  - For C1: Lower noise tyres had on average also lower prices (2% per dB)
  - For C2: Lower noise tyres had on average higher prices (2% per dB)
  - For C3: Lower noise tyres had on average higher prices (6% per dB)

Average Max – Ave (db)		
C1	C2	C3
1.0	1.0	1.3

- However, the trend was not consistent for all data sets. The average values above had a standard deviation of 15-30% indicating non statistical significant difference from 0%.

Consumers tyre testing data

Max – Ave = 1.6-1.7 dB

Tests from Auto-Motor und Sport, Auto Bild, Auto Zeitung, Allgemeiner Deutscher Automobil-Club (ADAC) and www.tyrereviews.com.

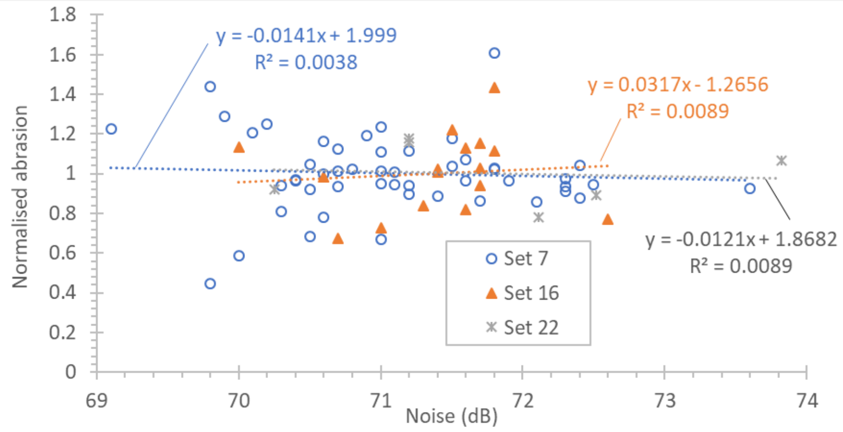
300 tyres from 63 manufactures out of which 50% from Michelin, Continental, Bridgestone, Goodyear, Falken, Hankook, Maxxis, Nexen, Pirelli.

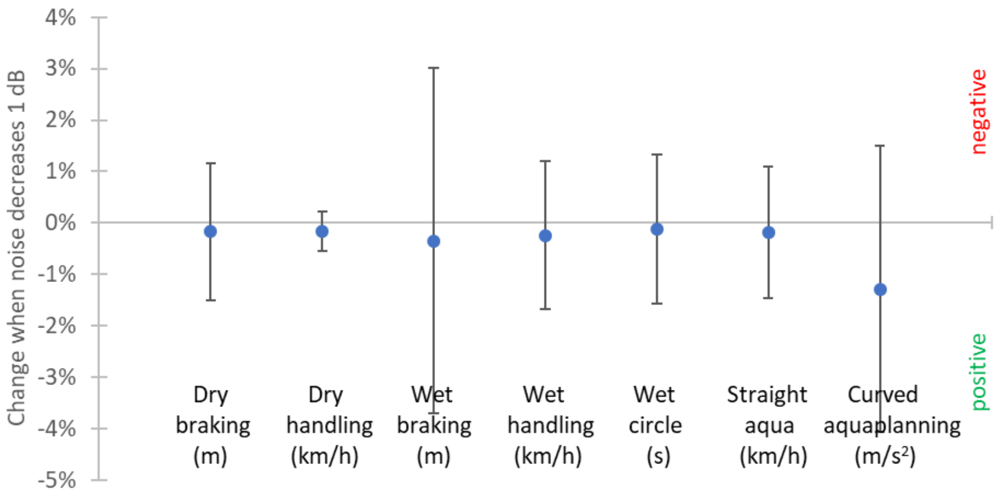
The average difference of max to average values is 1.6 dB to 1.7 dB (weighted with # of tyres)

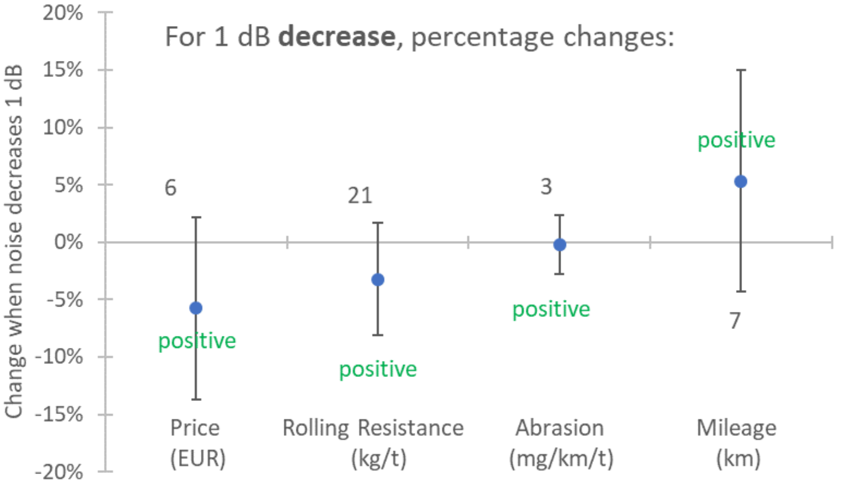
Set	Tyre size	#	Average	Min	Max
1	245/45 R19 102Y	10	69.3	67.3	71.1
2	245/40 R19 98Y	10	71.8	70.6	73.6
3	225/45 R18	11	72.9	70.8	74.1
4	215/55 R17	22	68.9	67.1	70.1
5	215/55 R17 94W	10	71.3	70.0	72.0
6	225/45 R17 91Y	9	70.1	67.8	72.5
7	205/55 R16 91V	50	71.1	69.1	73.6
8	225/40 R18 92Y	13	67.5	66.5	69.0
9	225/45 R18 95Y	21	73.1	71.9	75.3
10	235/35 R19 91Y	10	69.6	67.0	72.0
11	225/65 R17 106V	12	69.3	67.3	70.4
12	255/45 R20 105Y	10	72.7	71.9	73.5
13	205/55 R16	8	64.7	64.0	65.3
14	225/40 R18 92Y	11	71.3	69.7	73.3
15	205/55 R16 91V	13	71.4	70.2	72.8
16	215/55 R17	16	71.4	70.0	72.6
17	235/55 R18 100V	8	70.8	69.3	73.2
18	205/55 R16 91V	21	73.5	72.3	74.5
19	235/55 R19 105Y	9	70.3	68.6	71.3
20	235/55 R19	11	70.4	68.6	72.8
21	205/55 R16	9	72.2	70.2	74.4
22	245/45R19 102Y	6	71.9	70.2	73.8

Consumers data

- Correlation of noise with each parameter (calculation of slope)
- For each parameter: Calculation of average and std. dev. of slopes from all data sets
- Overall positive trends (i.e. for noise reduction, no worsening of other parameters)







Conclusions from data analysis

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- The average noise levels of the five best selling tyre sizes were:
    - for C1 tyres 70.5 dB, for C2 tyres 71.7 dB, for C3 tyres 71.5 dB
- Correlations of all data (all seasons, and sizes) or even separately for each tyre dimension showed a tendency of improved rolling resistance (RR) or wet grip (WG) with lower noise tyres. Thus, in general we do not expect worse performance by lower noise tyres. Tyres with the same RR and WG levels showed that lower noise tyres had higher price only for C2 and C3 tyres.
- Analysis of the consumers' tyre testing data: there is no significant effect of reduction of noise to any parameters (safety, abrasion, RR) and on average the impact was even positive.
- The data range (max – average) was around 1.6-1.7 dB for C1 tyres (consumers' data) and even lower for the EPREL data (1.0-1.5, except C3 2.9)
- A dedicated study by UTAC (ACEA) with 16 tyres, based on a statistical analysis, concluded that noise and handling improve together, but there is a conflict between noise and safety performances. No conclusion could be drawn for RR.

Limits for tyres and vehicles

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Table 4 : Limit values for vehicle sound of M2/M3 and N2/N3 categories and rolling sound of C2 and C3 tyres.

Limit values		Ph. 2	Ph. 3	Limit values – Stage 2		
M2	M ≤ 2.5 t	70	69	C2 No traction	Normal / M+S	72
	2.5 t < M ≤ 3.5 t	72	71		3PMSF	73
	M > 3.5 t; P_n ≤ 135 kW	73	72		Special	74
	M > 3.5 t; P_n > 135 kW	74	72	C3 Traction	Normal / M+S	75
M3	P_n ≤ 150 kW	74	73		3PMSF	76
	150 kW < P_n ≤ 250 kW	77	76		Special	77
	Pn > 250 kW	78	77			
N2	Pn ≤ 135 kW	75	74			
	Pn > 135 kW	76	75			
N3	Pn ≤ 150 kW	77	76			
	150 kW < Pn ≤ 250 kW	79	77			
	Pn > 250 kW	81	79			

R51.03 Transitional provisions for new type approvals:

Phase 2:	Mandatory for vehicles other than N2:	1 July 2020
	Mandatory for vehicles N2:	1 July 2022
Phase 3:	Mandatory for vehicles other than N2, N3, M3:	1 July 2024
	Mandatory for vehicles N2, N3, M3:	1 July 2026

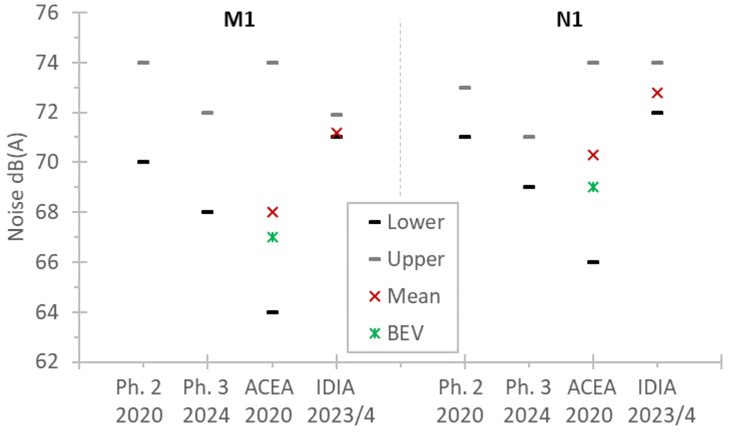
Table 2 : Limit values for vehicle sound of M1 and N1 categories and rolling sound of C1 and C2 tyres.

Limit values		Ph. 2	Ph. 3	Limit values – Stage 2		
M1	PMR ≤ 120	70	68	C1	185 and lower	70
	120 < PMR ≤ 160	71	69		Over 185 up to 245	71
	PMR > 160	73	71		Over 245 up to 275	72
	PMR > 200	74	72		Over 275	74
N1	M ≤ 2.5 t	71	69	C2	Normal / M+S	72
	M > 2.5 t	73	71		3PMSF	73
					Special	74

R51.03 Transitional provisions for new type approvals:

Phase 2: Mandatory for vehicles M1, N1: 1 July 2020

Phase 3: Mandatory for vehicles M1, N1: 1 July 2024



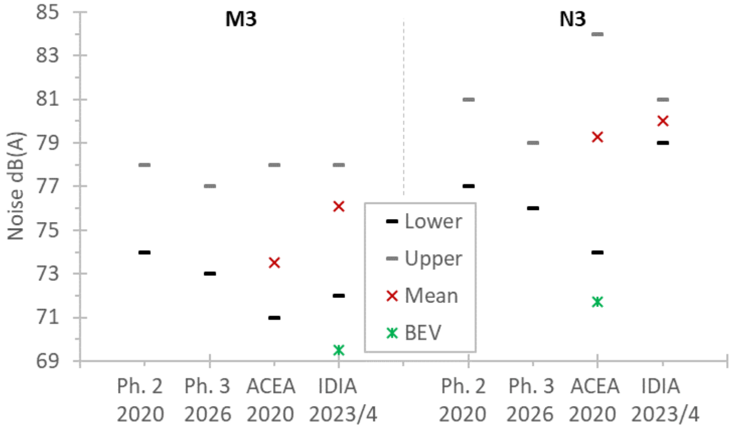


Table 7 : Summary of UN R51 test results at IDIADA (2023-2024).

Category	#	Propulsion type	Pass-by dB(A)
M1	5	ICE	71.2 (71.0-71.9)
M1	16	PEV	66.0 (64.0-68.0)
N1	4	ICE	72.8 (72.0-74.0)
N2	4	ICE	73.5 (73.0-74.0)
N2	2	PEV	72.0 (70.0-74.0)
N3	4	ICE	80.0 (79.0-81.0)
M3	20	ICE	76.1 (72.0-78.0)
M3	6	BEV	69.5 (64.0-77.0)
M3	1	FCEV	67.0

Table 8 : Overview of ACEA 2020 test results.

Category	#	Propulsion type	Pass-by dB(A)
M1 (L_{urban})	1655 (all)	ICE	68 (64-74)
M1 (L_{urban})	14	HEV	68 (64-71)
M1 (L_{urban})	27	BEV	67 (64-69)
M2 (L_{urban})	23	ICE	71.3 (69-75)
M3 (L_{urban})	42 (+2 BEV)	ICE	73.5 (71-78)
N1	156	ICE	70.3 (66-74)
N1	3	BEV	69 (67-71)
N2	74 (+2 BEV around 69)	ICE	72.4 (67-78)
N3	119 (+2 HEV around 79)	ICE	79.3 (74-84)
N3	6	BEV	71.7 (69-76)

$L_{urban} = L_{wot} - k_p * (L_{wot} - L_{crs})$,

$k_p = 1 - (a_{urban} / a_{wot})$,

$a_{urban} = 0.63 * \log10(PMR) - 0.09$

D6.3: Noise calculation tool

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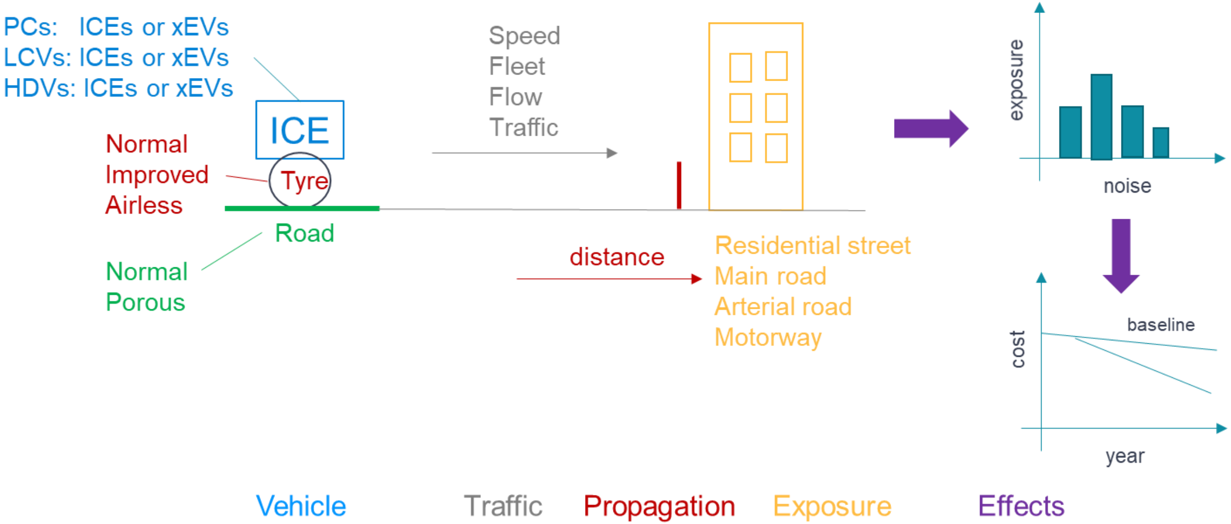
Previous relevant studies:

- Heimtsa 2011
- Venoliva 2011
- Phenomena 2021
- M-N noise study 2022
- ATEEL-ACEA 2022
- Handbook of costs 2019



Sub-categories

- **only internal combustion engine (ICE);**
- **only electric engine (BEV, FCEV);**
- **hybrids (mild, plug-in PEV)**

Table 20 : Model vehicle category *m* and tyres categories.

This model	CNOSSOS-EU	Vehicle categories	Tyres categories
PCs	Light vehicles	M1	C1
LCVs	Light vehicles	N1	C2
-	Medium-heavy >3.5 t	M2, M3 and N2, N3	C3
HDVs	Heavy	M2, M3 with trailer, M3, N3	C3

Table 21 : TA_R values used in the model based on UN Reg. 117.

Year	C1 (PC)	C2 (LCV)	C3 (HDV)	
2017	75	75	76	Stage 1
2025 +	71	72	75	Stage 2

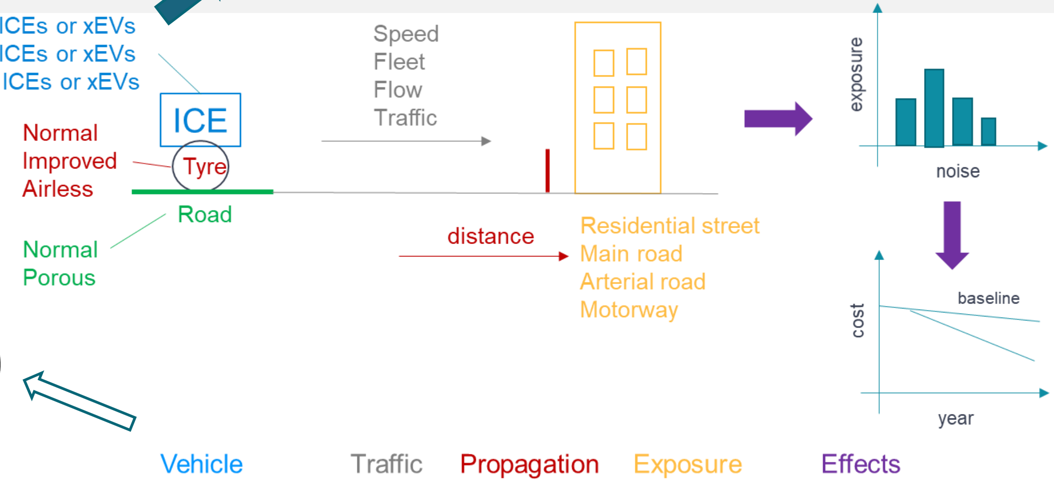
Table 22 : $L_{w,P,m}$ values used in the model based on UN Reg. 51 and UN Reg. 138.

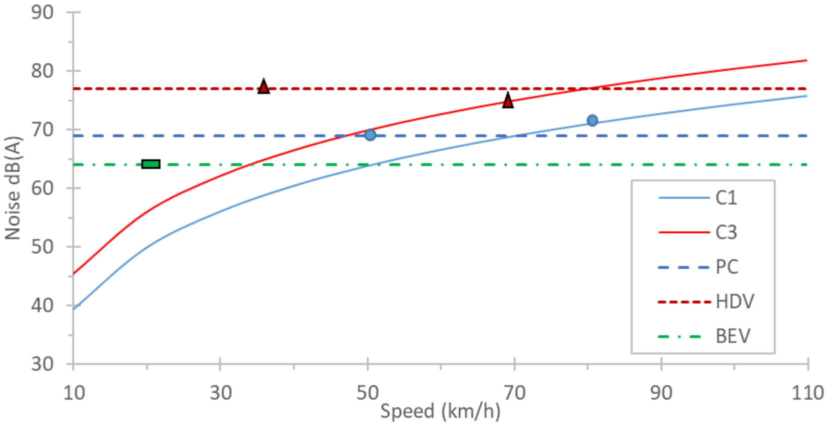
Year	M1 (PC)	N1 (LCV)	M3, N3 (HDV)	
2017	71	73	78	Phase 2 (ICE)
2025 +	69	71	77	Phase 3 (ICE)
2025 +	64	64	64	BEV/FCEV

+3 dB for real surfaces

$$L_{w,R,m}(v) = TA_R + 35 \log (v/v_{TA,R})$$

$$L_{w,m}(v) = 10 \log (10^{L_{w,R,m}(v)/10} + 10^{L_{w,P,m}(v)/10})$$





$$L_{w,m,corr} = L_{w,m} + \Delta L_{intermittent} + \Delta L_{road} + \Delta L_{barrier} + \Delta L_{offset}$$

If applicable: +3 dB(A) -5 dB(A) -10 dB(A) +3.5 dB(A)

Traffic

Only urban agglomerates were considered

	Road type	Traffic	Inhab. length (km)	Inhab./ km	Veh/ 24h	PC km/h	LCV km/h	HDV km/h
1	Residential	Intermit.	643,768	200	835 *	30	30	30
2		Free	321,884	200	668	50	40	40
3	Main	Intermit.	66,599	450	11,665 *	40	40	40
4		Free	133,197	450	9,332	50	50	50
5	Arterial	Free	94,118	500	23,426	80	80	70
6	Motorway	Free	3,824	1,000	51,820	100	90	90

* It was assumed that with intermittent traffic the vehicle flow is 25% higher than free flow.

Road	PC			LCV			HDV		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
1*									
2**	34	25.5	3.4	6.8	3.4	1.7	0.68	1.7	0.85
3*									
4	500	400	50	50	20	5	44	11	5
5	1100	1100	220	121	121	24.2	121	55	33
6***	2500	1875	625	250	187.5	62.5	287.5	182.5	111.3

* Road 1, 3: Increased 25% compared to 2 and 4 respectively due to intermittent traffic
** Road 2: Increased 70% compared to original source
*** Road 6: Increased 25% compared to original source

m=vehicle category
j=day, evening, night

$$L_{w,flow,m} = L_{w,m,corr} + 10 \log \left(Q_m / v_m / 1000\right)$$

$$L_j = 10 \log \left(10^{L_{w,flow,LD}/10} + 10^{L_{w,flow,LCV}/10} + 10^{L_{w,flow,HDV}/10}\right)$$

D6.3: Calibration of the model (2017) and scenarios

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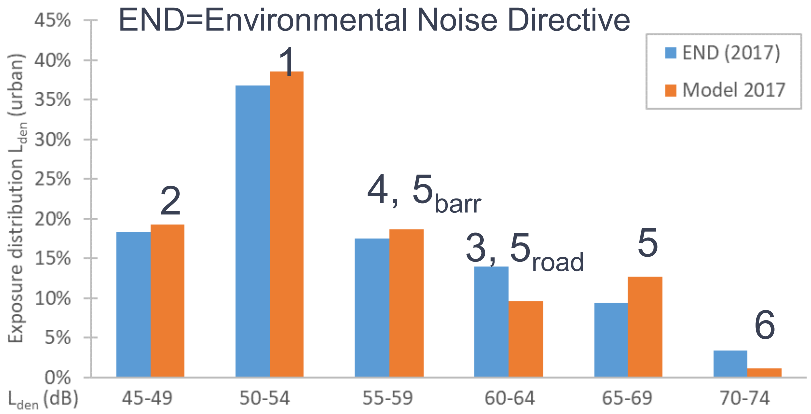
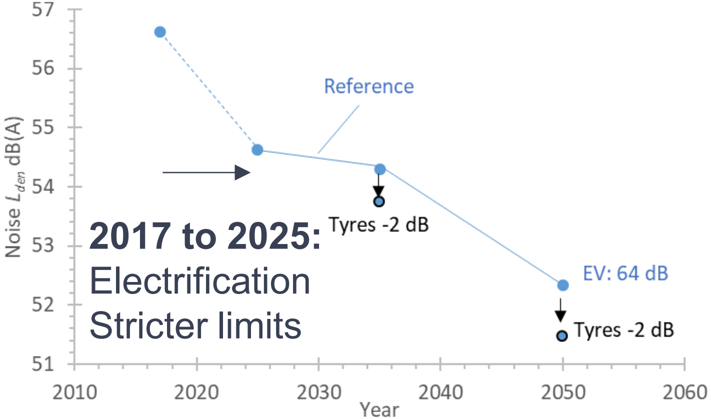




Small changes: population, fleet

Table 25 : Electrification shares over the years.

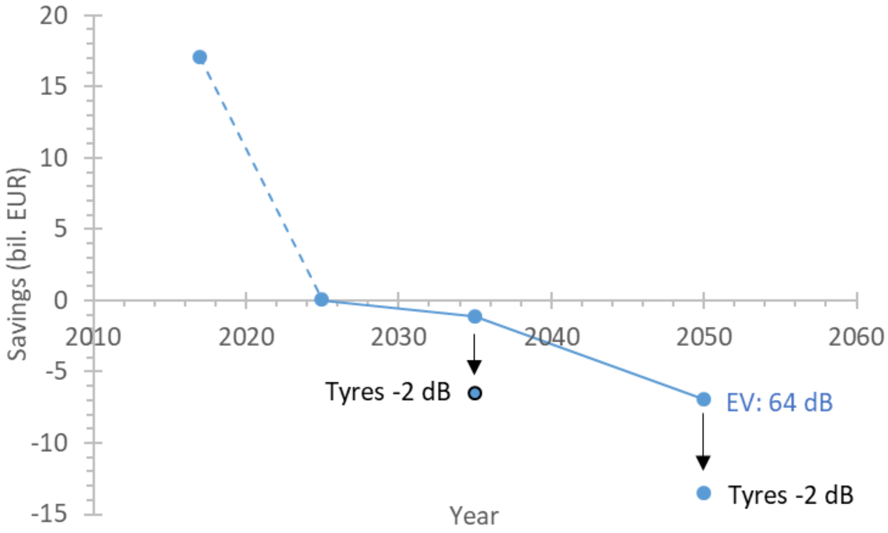
Category	Electrification	2017	2025	2035	2050
PC	Hybrids	0%	8%	10%	10%
	BEV/FCEV	0%	5%	30%	85%
LCV	Hybrids	0%	7%	8%	10%
	BEV/FCEV	0%	0%	20%	80%
HDV	Hybrids	0%	0%	5%	10%
	BEV/FCEV	0%	0%	15%	75%

For the reference scenario we assumed that 5% of the length of road #5 had quiet surface and 5% of the length of road #5 had barrier.

Table 26 : Exposure noise distributions. Measured END (2017), model calibration for 2017, calculated from the model from 2025 to 2050.

dB	END (2017)	2017	2025	2035	2050
<50	18%	19%	19%	19%	58%
50-54	37%	39%	39%	39%	1%
55-59	18%	19%	19%	19%	28%
60-64	14%	10%	22%	22%	13%
65-69	9%	13%	0%	0%	0%
70-74	3%	1%	1%	1%	1%
>75	0%	0%	0%	0%	0%
average		56.6	54.6	54.3	52.3

D6.3: Noise modelling results



Note:
Brakes 6.6 bil EUR savings in 2025-2050
Tyres 7-14 bil EUR savings in 2025-2050

Benefits

Electrification: 1 bil EUR savings only in 2035, and 12.5 bil EUR only in 2050.

Reduction of the tyre rolling noise by 2 dB(A) can save 5.5 bil EUR only in 2035 and 6.5 bil EUR only in 2050.

Costs

Testing and administrative: in total 0.3 bil EUR for the period 2025-2050

Research and development: in total 0.56 bil EUR for the period 2025-2050

Production (assuming 2% increase of tyres cost of 1/3 of the market tyres): 6.6 bil EUR for the period 2025-2050

D6.3: Future considerations for the model

- Ranking of tyres (and propulsion engines) on type approval surfaces and on real road surfaces might not be the same
- Impact of mitigation measures such as lower average speed, porous roads, greening, or fitting buildings with high insulating windows was not assessed in this study
- In non-urban areas, the average speed is high and the dominant noise source is the tyre, thus fleet electrification will not have a big impact.
- Contribution of other sources needs to be assessed (e.g. 2-wheelers), especially as vehicles (tyres and propulsion engines) become less noisy.

WP6: Conclusions

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- **Intermittent traffic noise** was generally found to be more disturbing than continuous noise of the same equivalent night-time level (**WP4**).
- It is suggested to go beyond energetic averages such as L_{night} and L_{den}, and consider additional noise metrics that capture the character of traffic flow and/or single events, such as the number of vehicles pass-bys, intermittency ratio and measures of maximum level such as $\mathbf{L_{AF,max}}$, and **tonality (WP4)**.
- The introduction of airless tyres, a promising solution, in the market is not easy and would need support either with dedicated projects or regulated steps (**WP5**)
- A reasonably **small (1-2 dB) reduction of pneumatic tyre noise is feasible** (from methodology and removing high emitting tyres) without compromising safety, rolling resistance and other parameters.
- The cost-benefit analysis showed that **noise reduction by fleet electrification results in huge benefits**. Tyre rolling noise reduction (and other measures not examined) can further enhance the result.

Thank you!

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- www.leont-Project.eu/the-Project/
- with the acknowledgements for the contributions from the entire LEON-T consortium

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