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LIFE E-VIA PROJECT: NOISE, ELECTRIC VEHICLES AND TYRES

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ABSTRACT

The LIFE E-VIA project tackles noise pollution from road traffic noise focusing on a future perspective in which electric and hybrid vehicles will be a consistent portion of traffic flow. Others main objectives of the project consist in: the combination of knowledge of road optimization and tyre development in order to test an optimized solution for reducing noise in urban areas and Life Cycle Cost with respect to actual best; the noise reduction for roads inside very populated urban areas through the implementation of a mitigation measure aimed at optimizing road surfaces and tyres of EVs (electric vehicles). From a practical point of view, two road surfaces, and at least five different EVs (including tyres specifically designed for EVs) will be tested. Finally, the soundscape holistic approach will be used to evaluate the performance of EV vs ICEV in the newly built scenario.

1. INTRODUCTION

The LIFE E-VIA project focuses on noise pollution due to road traffic, looking at a future perspective in which electric and hybrid vehicles will be a consistent portion of the traffic flow. Exposure data from the European Environment Agency (EEA) demonstrate that more than 100 million EU citizens are affected by high noise levels negatively impacting human health. Traffic noise alone is harmful to the health of almost every third person in the WHO (World Health Organization) European Region. 20% of Europeans are regularly exposed to night sound levels that could significantly damage health, especially in urban areas. As emerged in Noise in Europe Conference (April 2017) and in the WHO guidelines published in October 2018 [1], the increased stringency of EU at source standards needs to be balanced against other effective measures such as road surface and/or tyre improvements and urban planning measures as well.

One of the solutions universally recognized as the best to reduce noise in urban areas, from both the point of view of noise and air quality, is the introduction of electric mobility. In this framework, the European Commission started the EAFO (European Alternative Fuels Observatory). A first result that emerges is the growth trend of Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) in the market. Electric Vehicles (EV) circulating in Europe have reached half a

million in 2017, with 150.000 new registrations during the year, an increase of 43.9% compared to 2016.

These vehicles represented 0.9% of the market (in 2016 they were 0.6%). In the world, there are more than 3 million EVs (after November 2017) and International Energy Agency data indicate that there will be more than 125 million (until 220 million) in 2030, exceeding 50% of cars sold.

Traffic noise mainly consists of powertrain noise and tyre/road noise (i.e. rolling noise). With the progress of modern Internal Combustion Engines (ICE), tyre/road noise dominates after 40 kph for steady-speed traffic. This threshold is even lower for EVs with strongly reduced engine noise, thus leading to a higher relative contribution of tyre/road noise to the overall exterior vehicle noise. Similar effects can also be observed for the contribution of the tyre rolling resistance to the vehicle's energy consumption. This affects the emission of CO₂ and air pollutants, and the achievable mileage which is crucial for the public acceptance of EVs. Thus, for the changed requirements of EVs there is a need for in-depth investigations of tyre/road interaction. There were few projects considering this, and even less in relation to EVs. Those carried out (e.g. FOREVER) were focused on suburban/national roads or are rather dated. Other projects (e.g. LIFE NEREIDE, PERSUADE) aimed to surface noise optimization without focusing on fleet or tyres, thus lacking consideration of future developments in terms of BEV and PHEV fleet.

Last but not least, even for the application of the Directive 2002/49/EC, the coefficients to apply the CNOSSOS model (Directive 996/2015/EC) to new traffic spectra and new vehicles (e.g. EV) are completely missing. Results from FOREVER project towards a model for EV noise emission in CNOSSOS and further studies need to be improved and carefully populated before future implementation.

2. PROJECT OBJECTIVES

The project objectives are:

- 1) To reduce noise for roads inside very populated urban areas through the implementation of a mitigation measure aimed at optimizing road surfaces and tyres of EVs. Two road surfaces, at least five different EV types, one reference ICE Vehicle (ICEV) and at least three types of tyres per vehicle type (including tyres specifically designed for EVs) will be tested.

2) To estimate the mitigation efficiency and potential of tyres, pavements and traffic (traffic spectrum, speeds, handling conditions) at a higher and comprehensive level: a Life Cycle Analysis (LCA) and a Life Cycle Cost Analysis (LCCA) will be performed to demonstrate the individual and synergistic efficiency of pavement surfaces, tyres and vehicles (including the comparison between internal combustion vehicles, mixed traffic, and EV traffic).

3) To contribute to EU legislation effective implementation (EU Directives 2002/49/EC and 2015/996/EC), providing rolling noise coefficients within the Common Noise Assessment Method (CNOSSO-EU), specifically tuned for EVs which are actually in need of data for practitioners, agencies, and departments aiming at developing future scenarios.

4) To contribute to national and Italian regional policies, issuing guidelines about use and application of the methodology output of the project, which will be adopted, through the Regional Environmental Agency (ARPAT), supporting the project, by Tuscany Region, strongly interested in noise issues (partner of LIFE NEREIDE and Leopoldo project, and issued a law about control of road pavements with CPX method). Calabria Region and Città di Reggio Calabria also expressed their interest.

5) To raise people's awareness of noise pollution and health effects explaining the opportunities provided by EVs through specific dissemination and promotional events, also investigating people perception regarding noise in terms of soundscape methodology and involving them in noise data acquisition.

6) To demonstrate and promote sustainable road transport mobility (electric), reducing noise emission by 5 dB(A) at receivers roadside and achieving also CO₂ emissions reduction (21%), based on the Italian context (LPG, CNG, Hybrid, EV, petrol cars, diesel cars) and the concerned literature.

7) To encourage low-noise surfaces implementation in further EU and extra-EU scenarios, demonstrating durability and sustainability, through in-depth LCA&LCCA.

3. PILOT CHARACTER OF THE PROJECT

The LIFE E-VIA project presents all the characteristic of a pilot project, which are embedded in the development and testing of a new method, which has not been applied or tested before or elsewhere worldwide, for optimizing the tyres/low noise surfaces coupling, specifically for electric and hybrid cars, with the aim to reduce noise and to maintain performance and durability, without increasing costs with respect to standard surfaces and tyres. In fact, to reduce the health effects due to road traffic noise, the WHO guidelines published in October 2018 [1] strongly recommends that policy-makers

implement suitable measures to reduce noise exposure for the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, it is recommended to reduce noise both at the source and on the path between the source and the affected population by changes in infrastructure. Specifically, in the effectiveness evaluation of noise mitigation actions at the source, the improvements in the choice of appropriate tyres, road surfaces, truck restrictions and/or lower traffic flow should be mentioned.

Actually, according to the European Alternative Fuels Observatory, there is a very significant growth trend in the adoption of Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV). Moreover, electric cars strongly reduce engine noise and consequently mainly emit tyre/road noise. As a consequence, considering that in fast flow roads tyre/road noise becomes significant compared to engine noise, being able to reduce it is crucial. Thus, there is a widespread necessity to test and optimize the interaction between tyres and asphalt, this besides noise labelling of tyres. There were few projects considering the tyre/road interaction and even less in relation to EVs. Those carried out (e.g. FOREVER) were focussed on suburban/national roads or are rather dated. Other projects (e.g. LIFE NEREiDE, PERSUADE) aimed to surface noise optimization without focusing on fleet or tyres, thus lacking consideration of future developments in terms of BEV and PHEV fleet. Networking activities will be also carried out with the following previously funded projects, in particular:

- from LIFE NEREIDE (ongoing) project, the mixture design of low noise surfaces and innovative monitoring methodologies will be transposed;
- from FOREVER project results about electric vehicle noise emission will be applied;
- from LEO and COMPETT project results about CPX measurements of electric vehicle will be evaluated.

From the analysed state of the art, it turns out that the innovative contribution of the LIFE E-VIA Project will consist in the implementation of innovative solutions for enhanced quiet pavements for EV/hybrid vehicles for optimizing them from the acoustic point of view to reduce the exposure to noise. Results are expected to be obtained mainly based on techniques already applied in other contexts, though distinctly, such as measurement techniques through standard methods like CPX, CPB and SPB. Moreover, in the EU Directive 2015/996 a new subdivision of the vehicles into five classes has been carried out. In particular, the fifth class has been provided for any new vehicles that will be developed in the future and which may have such differences in terms of noise emissions as to justify the definition of an additional category. This category could include, still

according to the EU Directive 996/2015, electric or hybrid vehicles. In this frame, results from FOREVER project towards a model for EV noise emission in CNOSSOS and further studies need to be improved and carefully populated before future implementation and the LIFE E-VIA project will give an important contribution in this sense.

4. SCALE, OUTPUT AND EASY-REPLICABILITY

The project will also monitor and assess the efficiency of the mitigation measures in terms of LCA/LCCA, noise efficiency and soundscape approach. The project aims also at testing the benefits of electric cars in terms of noise and air pollution and their effectiveness in the urban context. Specifically, one pilot area has been selected, considering that preparatory and testing activities will be previously carried out in the prototypical area of Nantes. Here different tyres will be tested on different surfaces, considering local factors (climate, specific context, characteristics) of the pilot area. Once the considered optimized combination will be defined, it will be applied in the city of Florence.

Florence was the first Italian city to install a charging station for electric cars and motorcycles, the first to make available licenses for taxi drivers who work with electric cars only, and the first to have activated the car sharing of electric vans. In addition, the trends relating to the use of electric vehicles are constantly growing (there are currently about 2000 electric vehicles in circulation) along with the growth of charging stations (currently about 200). Finally, numerous incentives are provided at municipal level for the purchase of electric vehicles (since 2008, motions have been approved for Incentives to purchase low-emission, electric and pedal-assisted vehicles).

5. EXPECTED RESULTS AND OUTPUTS

The achievement expected from the LIFE E-VIA project are the following:

1. Reduction of noise levels for the sake of citizens health, for EV and ICEV, with pavements/tyres having life cycle costs comparable to those of standard road surfaces and tyres. Regarding reduction of CPX noise levels at 50kph, for the prototype optimized surface, a LCPX below 87 dBA is targeted with respect to the «comprehensive» criterion for low noise pavements of the EUGPPC. In comparison with the common old existing pavements, this implies a higher noise reduction at the source (at least 3 to 4 dBA) than the simple substitution by a common new dense-graded pavement (at least 2 dBA). Regarding Lden and Lnight, the proposed mitigation action should lead to a reduction of at least 5 dBA at receivers living at road side.
2. At the end of the project, about 2000 people are going to be positively affected by the reduction of noise

(Lden/Lnight reduction of at least 5 dB(A)), in the pilot area. Results and effects, measured during the project, will be modelled for the estimation in future applications. A quantification of health benefits in terms of Disability-Adjusted Life Year (DALY) reduction will be provided.

3. CO₂ reduction with electric cars use in the mitigated area, i.e. 29 tons CO₂ reduction per year (where the contribution of tyres was taken into account in terms of about 2 g/km). Specific actions are intended to promote electric market and raise awareness.

Tangible outputs of the LIFE EVIA project will be:

1. Development/testing/optimization of a new methodology for: the prediction of the noise emitted by tyres in contact with the proposed quiet pavement with the aim to optimize them in the future for a growing number of electric vehicles; adapting quiet pavements to the evolution of the car fleet by optimizing them from the acoustic point of view to reduce the exposure to noise where the transit speed determines an ineffective use of the electric motor due to the presence of rolling noise
2. New optimized road surface able to enhance performances of EVs, compliant with low-noise EUGPPC: improved environmental solutions (new quiet tyres for electric cars tested) capable of being widely taken up by the society in general and by the economy in particular.
3. New emission model for electric cars, helping EU legislation implementation: coefficients for rolling noise as for CNOSSOS-EU prediction model will be provided in order to evaluate their contribution within strategic noise mapping according to Directive 2002/49/EC.
4. New testing framework to develop surfaces for mixed fleets with increasingly electric and hybrid vehicles proportion.
5. Annual electric car festival to promote and support electric and sustainable mobility.

6. CONCLUSIONS

In Europe, the acoustic scenario at urban level is mainly characterized by road traffic noise. In this framework, the LIFE E-VIA project proposes some prototypical solutions leading with optimal road surface for the specific context of EV fleet and tyres to be developed in order to give an optimal holistic relation between low exterior noise and other key performances. These solutions are accompanied by soundscape analysis activities, estimation of EVs rolling noise coefficients for the local fleet in order to implementation of EU legislation, Life Cycle Analysis and Life Cycle Costing to evaluate the track efficiency from a comprehensive point of view.

First actions foreseen by the project scheduling have already been achieved and will be presented in detail in next papers.

REFERENCES

- [1] WHO, *ENVIRONMENTAL NOISE GUIDELINES for the European Region*, 2018.