LIFE E-VIA

"Electric Vehicle nOIse control by Assessment and optimisation of tyre/road interaction"

LIFE18 ENV/IT/000201

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Authors	Arnaldo Melloni, Iacopo Bianchi (FIRENZE)
	Raffaella Bellomini, Sergio Luzzi, Francesco Borchi, Lucia Busa, Chiara Bartalucci, Gianfrancesco Colucci, (VIENROSE)
	Filippo Giammaria Praticò (UNIRC)
Beneficiary	FIRENZE
Contact person	Arnaldo MELLONI
E-mail	arnaldo.melloni@comune.fi.it
Project Website	https://life-evia.eu/

Index

1 Introduction and objectives

The aim of Action C1 is to progressively verify that Implementation actions (actions B) are carried out according to the originally defined project objectives and that the quantitative expected results are actually obtained.

The monitoring of the impact of LIFE E-VIA project has been carried out according to the LIFE project performance indicators with particular regard to those suggested for the environmental issue.

Moreover, it has been possible to study the effects of the project actions on the local social system, which is represented by the changes produced by the intervention on the psycho-physic well-being of the residents and visitors of the involved area also by means of results obtained from the soundscape analysis, on its services and lifestyles, on the perception of the quality of the urban environment, the mobility systems, the economic activities, etc. In this context, the urban area in the neighbourhood of the pilot street has been considered as a space social system and a local community, and not as the urban land physically bounded. The used methodology has been an impact study based on an ex-ante and ex-post assessment representing the socioeconomic state (ex ante) and its evolution (ex post) by a mix of indicators related to environmental, social and economic aspects.

Moreover, the standard KPI have been defined at the project beginning, continuously monitored throughout the project duration and finalised concurrently with the project conclusion.

After the project's conclusion, the responsibility for the LIFE E-VIA project's impact monitoring prosecution is taken for 3 years by the city of Florence. Consequently, defined indicators will be estimated also for the 3 years after the Project's end.

2   Project indicators

2.1   Overview

According to the main aspects covered by the LIFE E-VIA project, specific indicators were defined concurrently with the project idea's drafting and related values have been adjusted during the project duration and evaluated at the end of the project. General categories of the addressed indicators are noise and noise-related health effects, soundscape, air quality and emissions, greenhouse gas emission, waste management, resource consumption, employment, awareness raising, website, behavioural change, surveys, capacity buildings, jobs and others (introduced by project partners).

Moreover, for each indicator, when available, values expected for the project's end and after three years since its conclusion are provided.

In Table 1 a complete overview of LIFE EVIA project indicators is provided.

Table 1: Project indicators overview according to the project proposal

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated Impact (Absolute values) dB	Estimated Impact (%)	Evaluating strategy
NOISE	Reduction of Lden and Lnight noise levels	-5	-	The estimation of noise exposure at receivers living roadside of the mitigation action has been evaluated within action B4. It was expected to have 5 dB(A) less than without mitigation at the end of the project. After 3 years since the project's conclusion, it is expected to have still 3 dB(A) decrease compared to current values.
	Reduction of LCPX	90	-	The measurements carried out within action B4 allowed the evaluation of track efficiency in terms of road/tyre noise. It was expected to have values lower than 90 dB(A) as required by GPP as initial value after the implementation of new surface. After 3 years since the project's conclusion, a value not greater than LCPX initial value + 2 dB(A) is required by GPP, and 92 dBA has been set as target.
	Soundscape: Improvement of acoustic perception and comfort of an optimized asphalt with respect to a standard one		50	The estimation of the perception's improvement has been verified according to the analysis of the questionnaires that have been collected during the three sub-actions of Action B5. After 3 years since the project's conclusion, it is supposed to have a perception's improvement (up to 70%) according to the foreseen increase in the realization of noise-optimized pavements.
	Soundscape: Improvement of acoustic perception and comfort of an EV with respect to a ICEV one		50	The estimation of the perception's improvement has been verified according to the analysis of the questionnaires that have been collected during the three sub-actions of Action B5. After 3 years since the project's conclusion, it is supposed to have a perception's improvement (up to 70%) according to the foreseen increase in the number of circulating EVs.
	Number of people directly positively affected by the reduction of noise at the end of the project (n.)	2000		The estimation is based on the evaluation of the number of residents in a buffer of 50 m from the Michelucci street's axis. After 3 years since the project's conclusion, it is expected that 7000 citizens will be positively affected by the higher number of EVs and optimized pavements.

	%HSD (Self-reported sleep disturbance)	From 21 to 15	Reduction of 29	These are average figures, mainly based on the following primary sources: EEA Technical report No 11/2010; WHO Environmental Noise Guidelines for The European Region, 2018. After 3 years after the project's conclusion, it is expected that only small variations with respect to the end-of-project situation occur, due to the small variations in terms of DB for both reference and optimised surface.
	Relative risk for hypertension	From 2,1 to 1,9	Reduction of 11	These are average figures, mainly based on the following primary sources: EEA Technical report No 11/2010; WHO Environmental Noise Guidelines for The European Region, 2018. After 3 years after the project's conclusion, it is expected that only small variations with respect to the end-of-project situation occur, due to the small variations in terms of DB for both reference and optimised surface.
	Relative risk of myocardial infarction	From 1,4 to 1,15	Reduction of 14	These are average figures, mainly based on the following primary sources: EEA Technical report No 11/2010; WHO Environmental Noise Guidelines for The European Region, 2018. After 3 years after the project's conclusion, it is expected that only small variations with respect to the end-of-project situation occur, due to the small variations in terms of DB for both reference and optimised surface.
	Percentage of the population highly annoyed (HA)	From 66 to 50%	Reduction of 25	These are average figures, mainly based on the following primary sources: EEA Technical report No 11/2010; WHO Environmental Noise Guidelines for The European Region, 2018. After 3 years after the project's conclusion, it is expected that only small variations with respect to the end-of-project situation occur, due to the small variations in terms of DB for both reference and optimised surface.
AIR QUALITY AND EMISSIONS	**SPECIFIC INDICATOR**	**Estimated Impact** **(absolute values) g/ year**	**Estimated Impact** **(%)**	**Evaluating strategy**
	PM	Reduction of 4000	Reduction of 23%	This is due to the progressive transition towards EVs in the Italian context. According to this trend, after 3 years since the project's conclusion a reduction of 7300 g/year is expected.
GREENHOUSE GAS EMISSION (GHG)	**SPECIFIC INDICATOR**	**Estimated Impact**	**Estimated Impact** **(%)**	**Evaluating strategy**

		(metric tons/year)		
	CO_2	Reduction of 29	Reduction of 21%	This is due to the progressive transition towards EVs and hybrid vehicles in the Italian context (cf. text of the proposal) and to the use of improved tyres. According to this trend, after 3 years since the project's conclusion a reduction of 32 tons/year is expected.
WASTE MANAGEMENT	**SPECIFIC INDICATOR**	**Estimated Impact**	**Estimated Impact (%)**	**Evaluating strategy**
	Tyres	2.4 tons per year	-	Recycling of CR into the friction course. Main assumptions: 1) density and percentage of CR and tyres. 2) Lengths as per project proposal. 3) Tyre type: common in commerce. After 3 years since the project's conclusion, it is expected that 6.8 tons per year will be recycled based on the laying of the LIFE E-VIA asphalt on a 500 m long road in Florence.
	Landfills saved	200 m^3 per each maintenance cycle	-	Recycling of CR into the friction course. After 3 years since the project's conclusion, it is expected that 500 m^3 of landfill will be saved based on the laying of the LIFE E-VIA asphalt on a 500 m long road in Florence.
REDUCED RESOURCE CONSUMPTION	**SPECIFIC INDICATOR**	**Estimated Impact (tons/year)**	**Estimated Impact (%)**	**Evaluating strategy**
	Mineral aggregates	0.1	-	This is due to the use of crumb rubber in friction course mixture. The derivation of this value depends on the following baseline: HMA density, dimensions, CR percentage (w/w). After 3 years since the project's conclusion, it is expected a reduced resource consumption of 0.3 tons/year based on the laying of the LIFE E-VIA asphalt on a 500 m long road in Florence.
COMMUNICATION, DISSEMINATION, AWARENESS RISING	**SPECIFIC INDICATOR**	**Starting value**	**Estimated Impact (%)**	**Evaluating strategy**

	Number of entities/individuals reached/ made aware	20000	-	The estimation has been based on the experience made by partners on previous LIFE projects and it is based on the several initiatives that have been planned to be organized during the project (mainly the EV Festival and the participation to the International Noise Awareness Day). Data about awareness raising has been collected during Action D1 by considering the number of citizens taking part in the several foreseen initiatives. After 3 years since the project's conclusion, it is expected that 35000 citizens will be made aware, considering that the project's activities and results will be advertised also for the three years after the end of the Project (general Section B6).
	Number of website's visits	70000	-	The estimation has been based on the experience made by partners on previous LIFE projects, data about the website visits has been collected during Action D1. Since the collection of data about the website visits will be assured for 3 years after the end of the project, it is expected to reach 170000 website visits.
	Number of entities/individuals changing behavior	2000	-	The estimation has been based on the hypothesis that, thanks to the activities to be carried out during actions D1 and D2 and to the letters of support sent to the project coordinator, a changing in the citizens' behavior in terms of sensibilization to EV and possibly purchasing of an EV in case of need to change their private or business car/scooter is expected. After 3 years since the project's conclusion, it is expected that 5000 citizens will change their behavior in terms of sensibilization to EV and possibly purchasing of an EV in case of need to change their private or business car/scooter. The estimation has been based on the activities to be carried out after the end of the project (Action B8).
REPLICATION / TRANSFER	N . of Replication / Transfer	3/RT1+3/RT5+1/RT1+2/RT2+3/RT4+3/RT6+3/RT7+2/RT7+1/RT1	-	According to Action B8 the following activities are expected to be carried out after the project's conclusion: 3 roads/RT1; 3 action plans/RT5; 1 implementation-road in other countries/RT1; 2 Festival-initiative/RT2; 3 coefficient applications/RT4; 3 CR-based initiatives/RT6; 3 guideline adoptions/RT7; 2 EV tyres/RT3+1 Spin off/TR1.

2.2 Evaluation

The current paragraph provides the values obtained at the end of the project, for each category of indicators, together with the methodology used for the evaluation. Where deemed necessary, also the evaluating strategy has been updated.

2.2.1 Noise

Table 2: Noise

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal	Estimated impact according to project proposal (%)	Actual value at project end	Comments and brief explanations of assumptions used for the calculation
NOISE	Reduction of Lden and Lnight noise levels (dBA)	-5	-	-4.4 (Lnight)	This reduction value was obtained following the implementation of noise and traffic measurement campaigns of weekly duration on receivers' façade in correspondence of the road stretch interested by the LIFE E-VIA asphalt laying (Action B5). Considering the uncertainty of measure, the indicator can be considered achieved.
	Reduction of LCPX (dBA)	< 90	-	87.5 +-1.5	This reduction value has been obtained according to the measurements carried out within action B4 which allowed the evaluation of track efficiency in terms of road/tyre noise.
	Number of people directly positively affected by the reduction of noise at the end of the project	2000	-	2000	This target has been confirmed considering the inhabitants in a buffer of 50 m from the section of Paisiello street (which replaced Michelucci street) interested by the pilot intervention.

2.2.2 Soundscape improvement

Table 3: Soundscape

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (dB)	Estimated impact according to project proposal (%)	Actual value at project end (%)	Comments and brief explanations of assumptions used for the calculation

| NOISE | Soundscape: Improvement of acoustic perception and comfort of an optimized asphalt with respect to a standard one | - | 50 | 50 | This target has been achieved according to questionnaires submitted and analysed in the frame of Action B5. |
| | Soundscape: Improvement of acoustic perception and comfort of an EV with respect to a ICEV one | - | 50 | 40 | This target has been achieved according to questionnaires submitted and analysed in the frame of Action B5. |

2.2.3   Reduction of greenhouse gas emissions (GHG)

Table 4: Greenhouse gas emission

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (t/y)	Estimated impact according to project proposal (%)	Actual value at project end (t/y)	Comments and brief explanations of assumptions used for the calculation
GREENHOUSE GAS EMISSION (GHG)	CO_2 reduction	29	21	3	The current indicators refer to the foreseen reduction of CO2 due to the progressive transition towards electric and hybrid vehicles and to the progressive use of improved tyres. For CO2, the emissions have been based on literature emission values of the current traffic spectrum (Diesel, EV, gasoline, LPG, CNG, Hybrid) and

					the same has been done over time under the assumption that the trend towards EV and less Diesel etc. is confirmed. In fact, it is noted that out of a total number of more than 50 million vehicles on the road in Italy at the end of 2016, about 6,000 were electric passenger cars (IA-HEV), while at the end of 2017 they were about 14000. These data build on the percentage of ICEs vehicles over years, where, in this case, both gasoline and diesel cars are relevant (and not only diesel, as for PMs). In practice, 1)In the situation at the beginning there will be a certain emission of CO_2/km, essentially due to diesel and gasoline cars. 2)Basically due to the decrease in the percentage of diesel and gasoline cars, at the end of the project, the emission of CO_2/km is lower

| | | | | | (lower percentage of these types of cars). |
| | | | | | 3) Based on the above, if we divide the decrease above by the number of years (about 3.6), the result is that there is a decrease of about 3tons per year (of CO_2) . |

2.2.4   Air quality and emissions

Table 5: Air quality and emission

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (g/y)	Estimated impact according to project proposal (%)	Actual value at project end (g/y)	Comments and brief explanations of assumptions used for the calculation
AIR QUALITY AND EMISSIONS	PM reduction	4000	23	400	The reduction of PM due to decrease in the use of diesel cars is just at the beginning of a cycle. Over the last years the decrease in the number of diesel cars has been unsatisfactory and lower than predicted. This is the main reason of the occurred deviation. The data above build on the following assumptions. The data were

					referred to a given section (300m), a given traffic (vehicles per year), a given quantity of mg of PM per km per type of vehicle (eg., 25mg/km for diesel cars). Because the data in the table refer to a decrease, the decrease of PM was basically derived based on the decrease of diesel cars.

2.2.5   Waste management

Table 6: Waste management

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal	Estimated impact according to project proposal (%)	Actual value at project end	Comments and brief explanations of assumptions used for the calculation
WASTE MANAGEMENT	Tyres (t/y)	2.4	-	0.2	The addition of high quantities of crumb rubber, CR, to the mixture was not possible to the negative consequences in terms of swelling and increase of the viscosity of the asphalt binder. This explains the reduction in terms of both tons per year and in terms of cubic
	Landfill saved (m³)	200	-	15	

					meters of landfills saved.

2.2.6 *Reduced resource consumption (excluding energy)*

Table 7: Reduced resource consumption

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (t/y)	Estimated impact according to project proposal (%)	Actual value at project end (t/y)	Comments and brief explanations of assumptions used for the calculation
REDUCED RESOURCE CONSUMPTION	Mineral aggregates	0.1	-	0.04	This is due to the use of crumb rubber in friction course mixture. The derivation of this value depends on the following baseline: HMA, CR, and aggregate density, dimensions, CR percentage (w/w). Even if multiple interventions are scheduled, the reduction in the use of crumb rubber as an additive in the bituminous mixture has caused the consequent reduction in the figure that refers to the "reduced resource consumption".

2.2.7 *Replication / Transfer*

Table 8: Replication/Transfer

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal at the project end (n.)	Actual value at project end (n.)	Estimated impact according to project proposal after 3 years since the project end (n.)	Updated expected impact after 3 years since the project end (n.)	Comments and brief explanations of assumptions used for the calculation
REPLICATION / TRANSFER	N. of Replication / Transfer	-	-	3 roads/RT1; 3 action plans/RT5; 1 implementation-road in other countries/RT1; 2 Festival-initiative/RT2; 3 coefficient applications/RT4; 3 CR-based initiatives/RT6; 3 guideline adoptions/RT7; 2 EV tyres/RT3+1 Spin off/RT1	RT1: 6 roads; spin off. In addition the procedure to set up the spin off has been initiated by UNIRC. RT2/RT6: 1 initiative dedicated to the project has been already planned; RT3: the new/adapted methodologies and processes developed under Action B7 will be used for future tyre developments; RT4: applications are planned for the next Round of Action Plans; RT5: 3 project-based	RT1: FIRENZE has already approved the laying of the LIFE E-VIA asphalt on additional 6 roads (Paisiello additional stretch, Cascine, Bolognese, Senese, Porte Nuove, Ponte alle Mosse) for an overall length of 2500 m. Spin off: a spin off was proposed at the department DIIES of UNIRC. RT2: *In* October 2023 a special session dedicated to the LIFE E-VIA outcomes will be planned in the frame of *Beautiful sounds* conference organized by FIRENZE. RT6: one initiative has already been organized with Ecopneus in march 2023. RT3: Action B8 analysed the economic impacts of all aspects related to the new developed tyres and the consequences for tyre development costs. It was found that based on the potential business benefits which can be gained from implementing the described methods an exploitation of the

| | | | | | actions plans foreseen. In addition, a 4th CPX monitoring campaign will be carried out after 3 years of surfaces realization to estimate the efficiency of pavements and a yearly monitoring campaign will be performed to estimate the efficiency of pavements in the prototypal test section in Nantes. | presented options should be worthwhile.

RT4: The implemented database and the coefficients for electric vehicles and asphalt, processed and tested on Via Paisiello, will certainly be used in the IV Round of Action Plans, as the switch to electric vehicles will certainly be used in the action plans of several managers of public transport, particularly in agglomerations.

RT5: Vienrose will propose the use of the LIFE E-VIA optimised asphalt to its customers, for whom contracts have already been awarded for the IV round of updating of the agglomerations' Action Plans.
Contracts already acquired are 6 (Municipality of Modena, Parma, Napoli, Milano and Monza, Perugia, Padova). |

2.2.8 Awareness raising

Table 9: Awareness raising

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (n.)	Estimated impact according to project proposal (%)	Actual value at project end (n.)	Comments and brief explanations of assumptions used for the calculation
AWARENESS RAISING	Number of entities/individuals reached/ made aware	20000	-	150770	This value has been obtained considering 600 people who attended the project's events, 500 people who attended

16

					conferences where project's results have been presented, 250 students involved in awareness lessons addressing also the project, 200 residents of via Paisiello who received informative letters about the project and the survey initiative, and the 1% (149140) of followers of 31 webpages/websites* which published news about the project, 80 participants to the soundwalks who have been informed about the project.

teleambiente (107,67), Toscana Oggi (105,32), Blogdaseguire (0,76), Circular economy network (34,8), Clubalfa (1011), Eco dalle città (138,98), Gripdetective (15224,4), Ingenio (739,96), InsideEVs (43,85), MacPlas (1,75), Repubblica (40091,83), Tyreandrubberecycling (36,02).

2.2.9   Website

Table 10: Website

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (n.)	Estimated impact according to project proposal (%)	Actual value at project end (n.)	Comments and brief explanations of assumptions used for the calculation
WEBSITE	Number of website's visits	70000	-	12576	Calculation has been made in the frame of Action C1 by VIENROSE, by monitoring website statistics made available by Google Analytics.

2.2.10 Behavioral change

Table 11: Behavioural change

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (n.)	Estimated impact according to project proposal (%)	Actual value at project end (%)	Comments and brief explanations of assumptions used for the calculation
BEHAVIOURAL CHANGE	Number of entities/individuals changing behaviour	2000	5	5	This value has been estimated considering that about 200 residents of Paisiello street have been informed about the project and the potentialities of EV. Added to these are all those who have attended presentations about the project and participated in events organized by it whose awareness of electric vehicles has been stimulated.

2.2.11 People interested by noise reduction due to the pavement optimization and to the EV enhancement

Table 12: People interested

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (n.)	Estimated impact according to project proposal (%)	Actual value at project end (n.)	Comments and brief explanations of assumptions used for the calculation
PEOPLE INTERESTED BY NOISE REDUCTION	Number of people directly positively affected by the	2000	-	2000	This target has been confirmed considering the

DUE TO THE PAVEMENT OPTIMIZATION AND TO THE EV ENHANCEMENT	reduction of noise at the end of the project				inhabitants in a buffer of 50 m from the section of Paisiello street interested by the pilot intervention.

2.2.12 Noise-related health effects

Table 13: Noise-related health effects

MACRO-INDICATOR	SPECIFIC INDICATOR	Estimated impact according to project proposal (%)	Estimated impact according to project proposal (%)	Actual value at project end (%)	Comments and brief explanations of assumptions used for the calculation
NOISE-RELATED HEALTH EFFECTS	%HSD (Self-reported sleep disturbance)	From 21 to 15	Reduction of 29	From 8,3 to 6	The actual reduction has been obtained according to the EC Working Group on Health and Socio-Economic Aspects, 2004. Position paper on dose-effect relationships for night-time noise. http://ec.europa.eu/ environment/noise/pdf/positionpaper.pdf (accessed January 2007). Brussels: European Commission.
	Relative risk for hypertension	From 2,1 to 1,9	Reduction of 11	Reduction of 9	The actual target value has been estimated according to the study "Cardiovascular effects of environmental noise: research in Sweden" by Bluhm, G. and Eriksson, C. https://pubmed.ncbi.nlm.nih.gov/21537104/, considering a reduction of about 1.4 dB(A) Lden.
	Relative risk of myocardial infarction	From 1,4 to 1,15	Reduction of 14	From 1,00433 to 1,00048	For the indicator evaluation, the Exposure-response function for myocardial infarction made available by EAA Technical report No 11/2020 has been used.
	Percentage of the population highly annoyed (HA)	From 66 to 50%	Reduction of 25	From 10,7 to 9,4	European Commission Working Group on Dose-Effect Relations, 2002. Position paper on dose response relationships between transportation noise and annoyance. http:// ec.europa.eu/environment/noise/pdf/noise_ expert_network.pdf (accessed January 2007). Luxembourg: Office for Official Publications of the European Communities.

3 KPI

3.1 Overview

KPIs were initially defined at the stage of project proposal preparation, from the project indicators, together with all partners.

Later, following the approval of the proposal and the guidance provided by the project monitor, the KPIs were slightly adapted, also to comply with the format required by the KPI webtool.

The KPIs were, in addition, monitored throughout the duration of the project and updated again at project closure.

In Table 14 a complete overview of LIFE EVIA project indicators is provided.

Table 14: KPIs overview according to the project proposal

INDICATOR DESCRIPTOR	VALUE AT THE BEGINNING	AT THE END	BEYOND 3 YEARS	COMMENTS
Conservation or improvement of the status of an area or segment (m)	0	150	450	The area length has been calculated considering a buffer of 50 m per side of the road where Pilot intervention will be realized. "Beyond 3 years" data are referred to the other 2 replicated areas that will be realized.
Persons whose lives were directly, positively impacted by MAIN envir. actions of project (n.)	0	2000	6000	Indicator values: "At the end": corresponds to number of inhabitants of Pilot Area. Indicator values: "Beyond 3 years": are determined supposing to replicate the action in 2 new areas (similar to the first one with regards to dimension and population).
Persons whose lives were positively impacted by SECONDARY envir. acts of project (n.)	0	2000	6000	Indicator values: "At the end": corresponds to number of inhabitants of Pilot Area. Indicator values: "Beyond 3 years": are determined supposing to replicate the action in 2 new areas (similar to the first one with regards to dimension and population).
Persons with improved capacity or knowledge due to project actions (n.)	0	2000	7000	Indicator values "At the end" corresponds to number of inhabitants of the Pilot Area. Indicator values "Beyond 3 years" are determined supposing to replicate the

				action in 2 new areas (similar to the first one with regards to dimension and population) and considering people external to the area that will be informed about project actions.
Mass of non-appropriately managed waste (t/y)	6.80	4.40	0	The current indicator refers to the tyres' saving due to the process of crumb rubber recycling into the friction course and values are based on the weight of tyres that will not be landfilled. This data can be also expressed in cubic meter of waste which will be not disposed in landfill: 200 m^3 by the end of the project and 500 m^3 three years after the end of the project.
Mass reduction due to recycling (t/y)	0	2.40	6.80	The current indicator refers to the tyres' saving due to the process of crumb rubber recycling into the friction course and values are based on the weight of tyres that will not be landfilled. This data can be also expressed in cubic meter of waste which will be not disposed in landfill: 200 m^3 by the end of the project and 500 m^3 three years after the end of the project.
Saving of mineral aggregate (t/y)	0.4	0.3	0	The current indicator refers to the saving of mineral aggregate that will be achieved thanks to the use of crumb rubber in the friction course mixture in terms of tons/year.
Noise level (dBA)	60	55	52	This reduction value was obtained following the implementation of noise and traffic measurement campaigns of weekly duration on receivers' façade in correspondence of the road stretch interested by the LIFE E-VIA asphalt laying (Action B5). Considering the uncertainty of measure, the indicator can be considered achieved.

In addition, it is supposed to move from 90 dBA or lower in terms of LCPX (track efficiency) at the end of the project to 92 three years after its conclusion. |
| PM (g/day) | 11 | 2 | 0 | For PM, the emissions have been based on literature emission values of the current traffic spectrum (Diesel, EV, |

				gasoline, LPG, CNG, Hybrid) and the same has been done over time under the assumption that the trend towards EV and less Diesel etc. is confirmed. In fact, it is noted that out of a total number of more than 50 million vehicles on the road in Italy at the end of 2016, about 6,000 were electric passenger cars (IA-HEV), while at the end of 2017 they were about 14000.
CO_2 (Kg/Km per person)	106700	32200	0	The current indicators refer to the foreseen reduction of CO_2 due to the progressive transition towards electric and hybrid vehicles and to the progressive use of improved tyres. For CO_2, the emissions have been based on literature emission values of the current traffic spectrum (Diesel, EV, gasoline, LPG, CNG, Hybrid) and the same has been done over time under the assumption that the trend towards EV and less Diesel etc. is confirmed. In fact, it is noted that out of a total number of more than 50 million vehicles on the road in Italy at the end of 2016, about 6,000 were electric passenger cars (IA-HEV), while at the end of 2017 they were about 14000.
CO_2 (t/y)	32	3	0	
Stakeholders involved (n.)	0	10	15	Overall category of stakeholders (e.g., representatives of Municipalities, etc.) to which project information are expected to be disseminated, based on a number of stakeholders taking part in public events/congresses, are estimated according to previous EU project experience both for *at the end* and *beyond 3 years* values.
Website – n. of unique visits (n.)	0	70000	170000	Estimations made according to the experiences of previous LIFE projects.
Publications/reports (n.)	0	40	40	The calculation has been made according to the number of publications and reports expected according to the project proposal.
Number of articles in print media (n.)	0	400	400	The calculation has been made considering 100 printed copies of brochures for each organised event.

Other distinct media products created (n.)	0	3	3	Other media: it is referred to 2 videos (1 of the prototype construction and 1 of the festival) and 1 radio campaign about the project.
Hotline/information centre (n.)	0	1	1	It is referred to the project website FAQ section.
Number of events/exhibitions organised (n.)	0	4	4	The calculation has been made according to the number of events expected to be organised according to the project proposal.
Number of different displayed information created (n.)	0	30	30	The calculation has been made according to the number of noticeboards expected to be created according to the project proposal.
Dissemination and awareness raising – students (n.)	0	700	800	The *at the end* and the *beyond 3 years* values are estimated according to results obtained in previous EU projects, considering organising educational workshops in about 30 high school classes by the end of the project and educational workshops, including project themes, in additional 3 classes 3 years after the project conclusion.
Dissemination and awareness raising – pupils (n.)	0	300	400	The *at the end* and the *beyond 3 years* values are estimated according to results obtained in previous EU projects, considering organising educational workshops in about 10 primary school classes by the end of the project and educational workshops, including project themes, in additional 3 classes 3 years after the project conclusion.
Professionals - experts in the field (n.)	0	1000	1500	According to results obtained in previous EU projects and to an estimation, it is expected that about 1000 professionals will participate in events organised in the frame of the project or in which project results will be presented at the end of the project and additional 500 professionals will participate beyond 3 years after the project conclusion.

Jobs (n. of FTE)	0	1	1	The provided value is related to a FTE employed during the Festival period.
Running cost/operating costs during the project and expected in case of continuation/replication/transfer after the project period (€)	0	1.797.030	2.027.030	The *at the end* value corresponds to the total project budget, the *beyond 3 years* value is estimated according to the intervention cost to be replicated in other 2 areas.
Dissemination and awareness raising (€) (Beneficiary own contribution)	-	-	10000	It is estimated that 2 partners will present project results in at least 2 Congresses beyond 3 years after project end.

3.2 Evaluation

The current paragraph provides the values obtained at the end of the project, for each category of indicators, together with the methodology used for the evaluation. Where deemed necessary, also the evaluating strategy has been updated.

Table 15: KPIs evaluation

INDICATOR DESCRIPTOR	VALUE AT THE BEGINNI NG	AT THE END (expect ed accordin g to project proposa l)	AT THE END (actual)	BEYOND 3 YEARS	COMMENTS
Conservation or improvement of the status of an area or segment (m)	0	150	150	4920	The area length has been calculated considering a buffer of 50 m per side of the road where Pilot intervention will be realized. "Beyond 3 years" data are referred to the 6 additional roads that will be re-paved. the overall cost per square meter of the asphalt, including the milling of 8 cm and the resurfacing of the binder, excluding VAT and ancillary charges is about € 30 per square metre (of which € 14.7 for the laying of the 4 cm surface course (new E-VIA asphalt), € 5.67 for the milling and € 9.32 for the binder). Below the calculation for the 6 roads: Budget allocated for Via Senese: 395.000 € (excluding VAT and ancillary charges) 395.000/30 = 13.160 mq = 1460 ml (average road width 9 m) Budget allocated for Via Bolognese: 395.000 € (excluding VAT and ancillary charges) 395.000/30 = 13.160 mq = 1460 ml (average road width 9 m) Budget allocated for Via delle Cascine, Second stretch Via Paisiello, Via delle Porte Nuove, Via del Ponte

					alle Mosse 540.000 € (excluding VAT and ancillary charges) 540.000/30 =18.000 mq = 2.000 ml (average road width 9 m) Stretches that will be resurfaced: • Via delle Cascine (all) 650 m • Second stretch Via Paisiello 450 m • Via delle Porte Nuove (all) 420 m • Via del Ponte alle Mosse 480 m (From Porta a Prato up to the crossroads to Via Benedetto Marcello) • Via Senese 1460 m (From Porta Romana up to the crossroads to Via Poccetti) Via Bolognese 1460 m (From Piazza della Libertà up the crossroads to Vicolo di San Marco Vecchio)
Persons whose lives were directly, positively impacted by MAIN envir. actions of project (n.)	0	2000	2000	8000	Indicator values: "At the end": corresponds to number of inhabitants of Pilot Area. Regarding the "Beyond 3 years" data, FIRENZE has already approved the laying of the LIFE E-VIA asphalt on additional 6 roads (Paisiello additional stretch, Cascine, Bolognese, Senese, Porte Nuove, Ponte alle Mosse) for an overall length of 2500 m and an indicative number of residents of about 8000, higher than expected.
Persons whose lives were positively impacted by SECONDARY envir. acts of project (n.)	0	2000	2000	8000	Indicator values: "At the end": corresponds to number of inhabitants of Pilot Area. Regarding the "Beyond 3 years" data, FIRENZE has already approved the laying of the LIFE E-VIA asphalt on additional 6 roads (Paisiello additional stretch, Cascine, Bolognese, Senese, Porte Nuove, Ponte alle Mosse) for an overall length of 2500 m and an indicative number of residents of about 8000, higher than expected.

Persons with improved capacity or knowledge due to project actions (n.)	0	2000	2000	9000	Indicator values "At the end" corresponds to number of inhabitants of the Pilot Area. Regarding the "Beyond 3 years" data, FIRENZE has already approved the laying of the LIFE E-VIA asphalt on additional 6 roads (Paisiello additional stretch, Cascine, Bolognese, Senese, Porte Nuove, Ponte alle Mosse) for an overall length of 2500 m and an indicative number of residents of about 8000, higher than expected. Moreover, additional 1000 stakeholders external to the area are still expected to be informed about project actions.
Persons who may have been influenced via dissemination or awareness raising project-actions (reaching)	0	n.a. (indicat or added during the revision phase)	153.284	190.164	The "At the end value" is calculated according to: number of project website visitors (2794), number of people who attended the project's events (600), number of reached students (250), number of people who attended conferences where project's results have been presented (500), 1% of followers of 31 webpages/websites* which published news about the project (149140). The "Beyond 3 years" value has been estimated considering the visits to the project's website (35000), the number of people (100) who will attend the technical session dedicated to the project during the Beautiful sounds event which will be organised in Florence in October 2023, participants to next Eurocities meetings (150), participants to the next conferences where project's results will be presented (300), dissemination of project's results via ARPAnews (800), participants to events with the presence of Ecopneus (250).

Mass of non-appropriately managed waste (t/y)	6.80	4.40	6.60	0	For the recycling of CR into the friction course main assumptions are: 1) density and percentage of CR and tyres. 2) Lengths as per project poposal. 3) Tyre type: common in commerce.
Mass reduction due to recycling (t/y)	0	2.40	0.2	6.80	The landfill saved is due to the fact that tires occupy large volumes in landfills. The addition of high quantities of crumb rubber, CR, to the mixture was not possible to the negative consequences in terms of swelling and increase of the viscosity of the asphalt binder. This explains the reduction in terms of both tons per year and in terms of cubic meters of landfills saved. For waste management and **crumb rubber-related consequences** (cf. section 3.1 - waste management-pilot area), note that these steps were followed to derive the figures: 1. Assessing the total mass of HMA (about 42t=width*length*thickness*density). 2. Assessing the total mass of CR needed (about 0.8t=total mass of HMA*percentage of CR). 3. Assessing the total number of tyres used (about 170=total mass of CR needed/mass of CR in one tyre). 4. Assessing the corresponding cubic meters of landfill saved (about 15= number of tyres*volume occupied by a tyre in a landfill). 5. Assessing the corresponding figures in terms of tons/year (based on the expected life, about 9 years), that is to say about 0.2 t/y (= number of tyres*mass of a tyre/expected life of friction course). This is the **"end value"**. 6. Assessing the corresponding value in the case of diffusion of the pavement technology, in

terms of beyond three years value (6.8t/y=new total mass of HMA/initial total mass of HMA above*0.2). This is the "**Beyond 3 years value".**

Importantly, the two figures above (0.2 and 6.8) imply corresponding decreases in the mass of non-appropriately managed mass (section 3.1 of KPI).
Note that the benefits above in terms of waste management are mainly due to the pavement technology implemented.

In summarising, for the recycling of CR into the friction course main assumptions are: 1) density and percentage of CR and tyres. 2) Lengths as per project proposal. 3) Tyre type: common in commerce. Importantly, the landfill volume saved is due to the fact that tires would occupy large volumes in landfills. Even if the addition of very high quantities of crumb rubber, CR, to the mixture was not possible due to the negative consequences in terms of swelling and increase of the viscosity of the asphalt binder (this explains the reduction in terms of both tons per year and in terms of cubic meters of landfills saved) the very satisfactory level of mechanistic properties and noise-related properties emerges as a point of strength of this pavement technology, resulting in clear advantages at least from few crucial aspects: 1) the holistic approach (where many factors are considered), which complies with LCC and LCA spirit and fundamentals. 2) The consequent perception of stakeholders, road agencies, plant owners, and businesspersons of a technology that works well and is easy to implement. 3) the possibility to recycle (instead of stockpiling/landfilling/burning) huge quantities of CR because of the huge quantities of square meters

					constructed per year in our cities. This growing conscience and these perceptions are worth of value and are vital more than having a single stretch of pavement with higher CR percentages.
Saving of mineral aggregate (t/y)	0.4	0.3	0.04	-	This is due to the use of crumb rubber in friction course mixture. The derivation of this value depends on the following baseline: HMA, CR, and aggregate density, dimensions, CR percentage (w/w). Even if multiple interventions are scheduled, the reduction in the use of crumb rubber as an additive in the bituminous mixture has caused the consequent reduction in the figure that refers to the "reduced resource consumption".
Noise level (dBA)	60	55	55.6 (Lnight)	56.6	The "begin value" and "end value" have been measured, not estimated. Only the "Beyond 3 years value" has been estimated. **Ante and post-operam noise measurements campaign have been performed.** 2 monitoring positions, in have been defined on receivers' façade: one in the road section interested by the LIFE E-VIA asphalt (150 m) and the other in the road section interested by a new standard asphalt (150 m). Ante-operam campaign carried out by VIENROSE - Period: 23rd June – 1st July 2021 I Post-operam campaign carried out by I-POOL + VIENROSE - Period: 17th – 28th September 2021 II post-operam campaign carried out by I-POOL + VIENROSE - Period: 21st – 30th November 2022 For the three periods: rainy days have been excluded and 4 weekdays have been considered for the comparison; weight according to different traffic flows have been applied. An average value of 60.0 dB(A) Lnight has been measured during the Ante Operam campaign.

					An average value of 55.6 dB(A) Lnight has been measured during the Post Operam campaign. The Beyond 3 years value is estimated considering the potential loss of performance (about 1 dB(A)). In addition, it is supposed to move from 90 dBA or lower in terms of LCPX (track efficiency) at the end of the project to 92 three years after its conclusion.
PM (g/day)	11	10,95	1,09	-	For PM, the emissions have been based on literature emission values of the current traffic spectrum (Diesel, EV, gasoline, LPG, CNG, Hybrid) and the same has been done over time under the assumption that the trend towards EV and less Diesel etc. is confirmed. In fact, it is noted that out of a total number of more than 50 million vehicles on the road in Italy at the end of 2016, about 6,000 were electric passenger cars (IA-HEV), while at the end of 2017 they were about 14000. The figures above illustrate that the reduction of PM due to decrease in the use of diesel cars is just at the beginning of a cycle. Over the last years the decrease in the number of diesel cars has been unsatisfactory and lower than predicted. This is the main reason of the deviation above. The data above build on the following assumptions. The data were referred to a given section (300m), a given traffic (vehicles per year), a given quantity of mg of PM per km per type of vehicle (eg., 25mg/km for diesel cars). Because the data in the table refer to a decrease, the decrease of PM was basically derived based on the decrease of diesel cars.
CO_2 (Kg/Km per person)	106,7	32,2	96,7	0	The current indicators refer to the foreseen reduction of CO_2 due to the progressive transition towards electric and hybrid vehicles and to the
CO_2 (t/y)	32	3	29	0	

					progressive use of improved tyres. For CO_2, the emissions have been based on literature emission values of the current traffic spectrum (Diesel, EV, gasoline, LPG, CNG, Hybrid) and the same has been done over time under the assumption that the trend towards EV and less Diesel etc. is confirmed. In fact, it is noted that out of a total number of more than 50 million vehicles on the road in Italy at the end of 2016, about 6,000 were electric passenger cars (IA-HEV), while at the end of 2017 they were about 14000. These data build on the percentage of ICEs vehicles over years, where, in this case, both gasoline and diesel cars are relevant (and not only diesel, as for PMs). In practice, 1)In the situation at the beginning there will be a certain emission of CO_2/km, essentially due to diesel and gasoline cars. 2)Basically due to the decrease in the percentage of diesel and gasoline cars, at the end of the project, the emission of CO_2/km is lower (lower percentage of these types of cars). 3) Based on the above, if we divide the decrease above by the number of years (about 3.6), the result is that there is a decrease of about 3tons per year (of CO_2).
Stakeholders involved (n.)	0	10	15	30	15 public bodies have been involved during the project (the number of 10 was incorrectly indicated). Target value has in fact been reached considering that: Università di Ferrara, Università di Genova, Università di Bologna, Università di Pavia, Università di Pisa, Politecnico di Milano, University of Hannover, A. Volta high school in Reggio Calabria, Provincia di Bolzano, Provincia di Como, Regione Valle d'Aosta, ARPA Veneto, ARPA Toscana, City of Paris

					and Bruitparif have been directly addressed by activities organised by the project, in addition to at least 10 cities participating to Eurocities meeting where the project has been presented. As a consequence, the *beyond 3 years* values will be higher than 15. The estimated value is 30, considering that after the end of the project, other stakeholders have been involved: - during the presentation of LIFE E-VIA in the event of the LIFE CLOWN project (Paris, 6/7 April 2023), directly invited by the City of Paris (direct contacts and networking activities with City of Torino and Centre de recherches routières, Bruxelles) - the Italian National Society of Acoustics was also involved as a stakeholder in the promotion and dissemination of the project results - the Lombardia Region in its Piano Triennale di Bonifica dell'inquinamento acustico included the optimised asphalt of the LIFE E-VIA project as a reference in the Lombardy Region for low-emission pavements.
Website – n. of unique visits (n.)	0	70000	8954	17000	Values obtained according to the monitoring carried out under Action C1.
Publications/reports (n.)	0	40	45	47	The calculation has been made according to the number of publications and reports carried out by the end of the project. Moreover, 2 papers are already expected to be published after the project conclusion.
Number of articles in print media (n.)	0	400	36	36	The number of printed copies of brochures has been lower than foreseen due to the fact that many events have been organised in digital mode. However, 100 copies of

				brochures have been respectively printed during each Expomove event; moreover 34 brief articles have been published in print media.
Other distinct media products created (n.)	0	3	3	3	The foreseen target value has been reached. However, Other media: it is referred to 2 videos (1 of the prototype construction and 1 of the festival) and 1 radio campaign about the project.
Hotline/information centre (n.)	0	1	1	1	It is referred to the project website FAQ section.
Number of events/exhibitions organised (n.)	0	4	4	4	The events/exhibitions organised in the frame of the LIFE E-VIA project have been: Webinar on the LIFE E-VIA projects and other contributions (14/05/2021) + stand at Expomove 2021 (7-9/10/2021), final event (7/10/2022) + stand at Expomove 2022 (5-8/10/2022)
Number of different displayed information created (n.)	0	30	34	34	The following noticeboards have been produced: 13 in English, 6 in French, 6 in German and 8 in Italian.
Dissemination and awareness raising – students (n.)	0	700	100	300	The value at the project end has been calculated considering: - 40 students addressed by CRD during lessons at the University of Applied Sciences in Hannover - 60 students of Liceo Volta in Reggio Calabria involved by UNIRC in the students contest and lessons The value 3 years after the project conclusion has been estimated considering disseminating the project's outcomes to students.
Dissemination and awareness raising – pupils (n.)	0	300	150	200	The value at the project end has been calculated considering 150 students reached by VIENROSE with INAD activities. The value 3 years after the project conclusion has been estimated considering disseminating the project's outcomes to students.

Professionals - experts in the field (n.)	0	1000	1100	1500	It has been estimated that 500+600 people attended conferences (500) and other events (600) where the project's results have been presented. It is expected that additional 500 professionals will participate to disseminative events beyond 3 years after the project conclusion.
Jobs (n. of FTE)	0	1	1.7	0.3	Compared to the original proposal, no new resource was used for the EV Festival but the (additional) resources that worked on the project for its entire duration were counted (1307:220:3.5). In the 3 years after the project's conclusion, it is estimated that a 0.3 FTE will be dedicated to activities related to the project.
Running cost/operating costs during the project and expected in case of continuation/replication/transfer after the project period (€)	0	1.797.030	1.768.850,86	1.676.500,0	The *at the end* value corresponds to the total costs incurred. The *beyond 3 years* value is estimated according to: - Planned noise measurements The fourth CPX campaign in the pilot case (10.000 €) and CPX+CPB measurements for 5 years after the project conclusion on the prototype in Nantes (25.000 € + 30.000 €). - Replication in Florence Costs related to repaving of additional 6 areas in Florence (1.600.000 €). - Dissemination activity Maintenance of the project's website (1.500 € - VIENROSE own funds) Presentation of E-VIA project results during 3 Eurocities meetings (2.000 € for each meeting - FIRENZE/VIENROSE own funds) Presentation in conferences (1.000 € VIENROSE/FIRENZE/UNIEIFFEL own funds) Publication of papers in scientific journals (3.000 € I-POOL/UNIRC own funds)
Capital expenditure expected in case of	n.a. (indicator	n.a. (indicat	n.a. (indicator	1.600.000	Costs related to repaving of additional 6 areas in Florence.

continuation/replication/transfer after the project period	added during the revision phase)	or added during the revision phase)	added during the revision phase)		
Dissemination and awareness raising (€) (Beneficiary own contribution)	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	11.500	Beneficiaries' contributions will concern: - maintenance of the project's website (1500 € - VIENROSE own funds) - presentation of E-VIA project results during 3 Eurocities meetings (2000 € for each meeting - FIRENZE/VIENROSE own funds) - presentation in conferences (1000 € VIENROSE/FIRENZE/UNIEIFFEL own funds) - publication of papers in scientific journals (3000 € I-POOL/UNIRC own funds)
Future funding	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	1.676.500	Beneficiaries contributions will concern: - replication of the new asphalt in 6 additional areas in Florence (1.600.000 € - FIRENZE own funds) - noise measurements in Nantes and in Paisiello street in Florence (65.000 € - UNIEIFFEL and I-POOL own funds) - maintenance of the project's website (1500 € - VIENROSE own funds) - presentation of E-VIA project results during 3 Eurocities meetings (2000 € for each meeting - FIRENZE/VIENROSE own funds) - presentation in conferences (1000 € VIENROSE/FIRENZE/UNIEIFFEL own funds)

				- publication of papers in scientific journals (3000 € I-POOL/UNIRC own funds)
Entry into new entities/projects	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	n.a. (indicator added during the revision phase)	In addition to replication activities included in Indicators 14.1, 14.2 and 14.3, three replication activities are envisaged with no specific costs for beneficiaries. 1) Project-based Action Plans Vienrose will propose the use of the optimised asphalt proposed by the LIFE E-VIA project to its customers, for whom contracts have already been awarded for the IV round of updating of the agglomerations' Action Plans. This goes beyond the perspectives defined in the proposal phase (3) as, at the date of writing of this document, the contracts already acquired are 6 (Municipality of Modena, Parma, Napoli, Milano and Monza, Perugia, Padova). 2) Cnossos improved data base for strategic noise mapping The implemented database and the coefficients for electric vehicles and asphalt, processed and tested on Via Paisiello, will certainly be used in the IV Round of Action Plans, as the switch to electric vehicles will certainly be used in the action plans of several managers of public transport, particularly in agglomerations. 3) Possible future development of tyre product lines For possible future tyre development processes, CRD will exploit both of two main enablers deriving from the project activities: the additional know-how gained during action B7 on how to incorporate accelerated pass-by noise testing into the tyre development process in the best way and the adaption of development processes to the special requirements of the holistic noise optimised EV tyre.

4   Conclusions

From the evaluation of the identified KPIs and project's indicators it emerged that some deviations from the targets originally set occurred, however mainly concerning topics not strictly related to the LIFE E-VIA main objectives:

- The mass of non-appropriately managed waste (t/y) which turned out to be lower than expected since the addition of high quantities of crumb rubber, CR, to the mixture was not possible to the negative consequences in terms of swelling and increase of the viscosity of the asphalt binder. This explains the reduction in terms of both tons per year and in terms of cubic meters of landfills saved.
- The saving of mineral aggregate (t/y) was lower than expected. In fact, even if multiple interventions have been scheduled, the reduction in the use of crumb rubber as an additive in the bituminous mixture has caused the consequent reduction in the figure that refers to the "reduced resource consumption".
- The PM (g/day) reduction was lower than expected. In fact, the reduction of PM due to decrease in the use of diesel cars is just at the beginning of a cycle. Over the last years the decrease in the number of diesel cars has been unsatisfactory and lower than predicted.
- The reduction of CO2 emissions (Kg/Km per person) was lower than expected. In fact, it is noted that, for example, over the years 2019-2022, the increase of the number electric vehicles in Italy has followed a quite unsatisfactory trend.

Otherwise, better than expected results have been achieved for the dissemination and awareness raising, for the number of displayed information created and for the number of publications.