L-vehicles Emissions and Noise mitigation Solutions

D2.13
Legacy exploitation plan

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Executive summary

This deliverable outlines a broad post-project action plan for all partners and includes the 'result ownership list' as an annex. It presents a coordinated approach for the continued use of the LENS project's outcomes, aiming to ensure their long-term value in commercial, scientific, and policy contexts. The document reflects on achievements made during the project and identifies realistic opportunities for further collaboration and knowledge sharing among the participating organisations and wider stakeholder community.

Throughout the project, active dissemination and outreach activities resulted in a strong presence at scientific events, in publications and at public engagement activities. Flexible and inclusive communication formats helped to maintain participation and visibility, even when external challenges arose.

The legacy exploitation plan focuses on five areas: market take-up, scientific development, policy integration, certification and standardisation, and the continued use of scientific knowledge. In commercial terms, several of the developed tools and methods have potential for further refinement and practical application in relevant markets. These include new measurement systems, testing procedures, and calibration methods designed to improve the accuracy of emissions and noise assessments.

In the scientific domain, project results have been disseminated through academic networks, integrated into teaching, and utilised to inform academic networks, integrated into teaching, and used to guide new research directions. The generated data and methodologies continue to support studies on emissions, noise, and sustainable mobility.

From a policy perspective, the deliverable encourages ongoing dialogue with authorities and initiatives that aim to reduce vehicle emissions and noise pollution. The project's work on certification and standardisation also offers a basis for aligning technical methods with future regulatory developments.

In conclusion, D2.13 provides a balanced and forward-looking roadmap for sustaining the impact of the LENS project. It supports continued cooperation, learning, and responsible use of its results to contribute to cleaner and quieter mobility across Europe.

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1 Introduction

This document outlines the post-project exploitation of the LENS project results, encompassing the collected measurement data and methodologies, newly developed equipment and sensor technologies, as well as policy recommendations.

The LENS outputs also include a results ownership list, which details the intellectual property (IP), data collected, and techniques developed by each partner. This document is provided as an annex to this deliverable and is based on the initial outline of IP and technology readiness levels specified in the grant agreement (Part B, P27).

As exploitation and dissemination represent cross-cutting activities involving all LENS partners, input was gathered to identify stakeholders and leverage existing partner networks. The exploitation achievements realised during the project's duration are highlighted in the initial chapters of this deliverable.

The legacy exploitation plan, which is structured around commercial, academic, and policy frameworks, remains aspirational and is subject to external factors, including potential future commercial collaborations, project proposals, and participation in relevant events.

1.1 Exploitation during the LENS project

Based on the updated KPIs and plans outlined in deliverable D2.7 'Final Plan for Dissemination and Exploitation Including Communication', an assessment of the achievements related to the project's communication and exploitation activities has been conducted. This section briefly discusses the KPIs, addresses mitigation measures, and summarises the outreach activities. Further detailed information on these activities is available in deliverable D2.11 'List of Scientific Papers & Presentations at International Conferences/Events'.

Key Performance Indicators

As illustrated in the table below, the LENS project has exceeded its planned targets for communication activities, largely due to effective collaboration with the stakeholder group. This group expanded during the latter half of the project and contributed to the strong hybrid attendance at the final conference, overall, the final conference attracted about 70 participants.

The challenges associated with Twitter/X have already been addressed in the above-stated deliverable D2.7 and were offset by the strong performance on LinkedIn. In addition to the reported number of scientific publications, these dissemination efforts will continue.

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Assessment of outlined KPIs

	Indicator	Midterm	Project End	Final result data (11/2025)
Website	Visits	100/month	200/month	340
Newsletter	Subscribers	50	100	216
LinkedIn	Followers	150	250	305
Twitter	Followers	50	150	48
Scientific articles	Published/Citations	2 minimum	8 minimum	Outlined in D2.11
External events	Total attended/presented	20	40	Outlined in D2.11
Stakeholder Group	Members	10	15	33

1.2 Response to the mitigation measures

The identified challenges included: meeting the KPI for scientific publications as defined in the Grant Agreement; unsuitable weather conditions that could potentially delay on-site measurements; changes to on-site testing locations due to difficulties in coordinating with local authorities; and increased costs associated with events and hospitality.

Fortunately, either the envisaged risks did not materialise, or the LENS consortium was able to effectively address all identified challenges. Weather conditions during the on-road testing phase were favourable, enabling the participating LENS partners to organise site events at all three pilot locations with the active involvement of the stakeholder group and local participants. As noted, the KPI related to scientific publications was achieved through an increased output towards the end of the project. Furthermore, the impact of inflation-related cost increases was mitigated by selecting a more cost-effective venue in Brussels and adopting a hybrid format, which facilitated broader participation from external stakeholders across Europe and beyond.

1.3 Outreach activities

Successful activities during the LENS project

In addition to the three successful site visits to the pilot locations, several webinars and events were organised during the second half of the project, enhancing the dissemination of LENS results and engagement with stakeholders:

Two one-hour webinars presented the outcomes of the tampering in-field surveys at the pilot sites and the exhaust gas measurements from both laboratory tests and real-world driving using portable emissions measurement systems. Around 60 stakeholders attended, including representatives from the L-vehicle industry, project partners, and members of the LENS stakeholder group.

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A two-hour online event titled 'Sound of Silence? – Citizens' Perspectives on Noise Pollution' complemented participation in 'Motorrad-Lärmtag 2025', organised by German citizens' initiatives against noise pollution in Berlin in May 2025.

The project was also showcased to the European Commission and at the 17th session of the Task Force for Vehicle Sound, a sub-group of the Working Party on Noise and Tyres of the United Nations Economic Commission for Europe in Geneva.

Moreover, LENS partners shared project findings at major scientific events such as the European Aerosol Conference 2025, Internoise 2024, and the ETH Nanoparticles Conference, further strengthening the project's visibility within the scientific and stakeholder communities.

Potential future outreach activities

Future outreach efforts will focus on maximising the visibility and long-term impact of the LENS results through cooperation with related projects and participation in major scientific and policy events.

Collaboration with projects involving overlapping partners will enable joint dissemination and knowledge exchange. Cooperation with the REALCHEM project (POLIS and EMISIA) and the VERA project is planned, with both potentially contributing to a joint presentation during the POLIS Conference 2026. This will allow for broader dissemination of complementary findings and reinforce synergies between initiatives addressing sustainable mobility and emissions reduction.

Regional and international events linked to LENS partners will also serve as important dissemination platforms. KU Leuven is expected to contribute to the 2026 Leuven Conference on Noise and Vibration Engineering, the biannual ISMA Conference in Leuven, the biannual EARPA FORM Forum in Brussels, and the annual Flanders Make Symposium and scientific conference held across Flanders. RWTH Aachen University is likely to engage through the Aachen Acoustics Colloquium and activities of DEGA, while TU Graz plans to present project outcomes at the Euronoise Conference 2026 in Graz.

Together, these activities will extend the project's visibility, promote continued collaboration, and ensure the practical uptake of LENS findings in both research and policy contexts.

2. Legacy Exploitation Plan

The following segment highlights plans related to commercial, scientific, and policy take-up of LENS results, which are based on the submitted suggestions of all project partners.

2.1 Market Take-up (Commercial Exploitation)

The LENS project has delivered a range of technologies and methodologies that have been successfully translated into commercial activities. Several partners are actively exploiting these results to offer innovative products and services across multiple markets.

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IDIADA has utilised its expertise in on-road exhaust gas measurement methods and running resistance assessment to provide consultancy services to OEMs. Its integration of prototype and commercial on-road measurement systems, including different particle emission measurement systems, into L-category vehicles has facilitated advanced real-world testing capabilities. New configurations have also been developed for exhaust adaptation, OBD data logging, and equipment installation.

HORIBA continues to deploy and market SEMS and MiniPEMS instruments worldwide through its branches in Japan, India, the United States, and the United Kingdom. The company applies these devices to on-road and off-road projects, including funded marine emission studies. Innovations include lightweight measurement solutions for measuring gaseous pollutants, PN10 and PN2.5 laboratory units, and a novel calibration method for particles smaller than 10 nm.

IFPen ensures the ongoing commercial application of LENS technologies by refining the SEMS system and the GECO Air application. These are being further developed using data from L-category vehicle integration. The REAL-e lightweight portable system has proven to be efficient even for small mopeds, broadening the market potential. Results are shared with public authorities and OEMs to encourage practical deployment.

EMISIA has incorporated LENS findings into its commercial COPERT emission modelling tool, updating emission factors and continuing the development of SEMS prototypes for small vehicles. TNO leverages LENS methodologies for environmental and acoustic assessment in projects related to noise mitigation and automated tampering detection.

Overall, the market take-up of LENS results demonstrates strong readiness for commercial exploitation. The project's outputs have been transformed into tangible products and services that meet real industry needs and provide a lasting foundation for further innovation and economic impact.

2.2 Scientific Take-up (Academic Curricula, Scientific Papers, Further Research)

The scientific community has benefited from the LENS project, which has opened new research avenues, produced valuable academic resources, and generated training material for higher education.

Building on its expertise in exhaust gas emission measurement and PN2.5 nm particle instrumentation, TU Graz expanded its research activities and shared findings widely with the academic and research communities. The results have been integrated into master's and PhD courses such as Environmental Sensing and Advanced Sensor and Actuator Systems. Ongoing investigations focus on particle emissions below 2.5 nm and on non-exhaust emission sources. Through the creation of an extensive database of real-world pollutant emissions from L-category vehicles, IVL has advanced the understanding of small vehicle emissions.

The results have been published in scientific journals, presented at international conferences, and incorporated into university teaching and student projects, while also forming the basis for new

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research proposals. Progress in vehicle acoustics research has been achieved at RWTH Aachen University through the development of an on-board acoustic sensor system and comprehensive sound and vehicle dynamics databases. These outcomes have been integrated into courses on motorbike and vehicle acoustics, as well as into the supervision of Bachelor's and master's theses.

Further contributions come from KU Leuven, where LENS results have been extended into research on the acoustic behaviour of dynamic systems, including electric powertrains and industrial machinery. The findings are embedded in Bachelor's, Master's, PhD, and lifelong learning programmes, including the ISAAC Seminars on Acoustics. Meanwhile, EMISIA has enriched the scientific discourse through multiple publications addressing particulate emissions, tampering behaviour, and cost–benefit analysis of mitigation strategies. The organisation has also initiated new research proposals at both national and European levels.

Together, these efforts have strengthened the scientific foundations of emissions and acoustics research across Europe. LENS has stimulated further studies, created enduring educational resources, and ensured that its outcomes remain actively embedded in academic and research practice.

2.3 Policy Take-up (Integration of LENS Outcomes into Policies)

The policy recommendations, which are based on the deliverable D6.5 'Recommendations for quieter and cleaner LVs', have been disseminated in the final brochure as part of deliverable D2.14 'A LENS on noise and emissions of L-category vehicles'. The content of this brief and accessible summary of the project helps to engage with European, national, and regional policymakers at different levels. Since several engagement events are still planned for the period after the successful conclusion of the project, these will fall into the legacy exploitation plan. This includes planned bilateral meetings to present the projects to dedicated experts of the European Commission.

POLIS is transforming LENS outcomes into policy action. It promotes the adoption of L-category vehicle pollution control measures in urban environments and advocates for anti-tampering enforcement, the deployment of noise cameras, and improved pollution mitigation strategies. LENS results are actively disseminated within POLIS working groups on clean vehicles, air quality, as well as active travel and health. The organisation also aims to continue the collaboration with the Zero Pollution Stakeholder Platform and EU bodies such as DG ENV and DG GROW to align project evidence with legislative initiatives.

Policymaking has been strongly supported through the development of environmental assessment methods and mitigation scenarios for noise and emissions, advanced by TNO to help authorities design and implement effective enforcement strategies. Further contributions were made by IFPen through the public dissemination of SEMS and app-based monitoring tools, which assist public authorities in integrating real-world data into environmental management systems. Together, these initiatives have created a robust bridge between scientific evidence and policy implementation.

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2.4 Certification and Standardisation

The LENS project has made contributions to enhancing the accuracy, transparency, and reliability of certification and standardisation procedures for emissions and noise. Within this framework, testing specifications were developed by RWTH Aachen to bridge laboratory-type approval procedures with real-world performance. This work directly supports the ongoing revision of UN/ECE and ISO frameworks and reinforces the credibility of noise measurement methodologies.

Validated real-drive cycles and corresponding laboratory verification procedures, aligned with regulatory requirements, were created by TU Graz. Complementing these efforts, EMISIA designed on-road emissions measurement methods compatible with certification standards and developed validated databases to underpin type approval testing.

Regulatory consistency was further strengthened through IDIADA's work on running resistance determination and real-world validation procedures, while TNO advanced compliance monitoring by developing detection algorithms for identifying acoustic and emission events. In parallel, HORIBA established calibration methods for sub-10 nm particle measurements, setting new benchmarks for precision in both laboratory and certification environments.

Collectively, these achievements ensure that LENS methodologies remain relevant and applicable to future type approval processes. The resulting improvements in accuracy and harmonisation enhance Europe's capacity to assess and regulate vehicle emissions and noise performance with greater confidence and transparency.

2.5 Use of Scientific Knowledge and Devices

The knowledge and technologies developed through LENS are being actively applied beyond the project, demonstrating their scientific and practical value. New measurement systems, including SEMS, MiniPEMS, and REAL-e, have been adapted and validated for L-category vehicles. These tools allow accurate on-road assessment of exhaust and noise emissions under real driving conditions. Innovations such as OBD-based exhaust flow estimation and modular mounting concepts now enable more efficient and less invasive data collection.

Comprehensive databases created by IVL, TU Graz, KU Leuven, and RWTH Aachen, covering emissions, acoustic signatures, and driving patterns, serve as a reference resource for future research and technological innovation. These datasets underpin the development of emission models, mitigation strategies, and regulatory updates. The application of LENS tools extends to new domains: HORIBA and IFPen are deploying their measurement systems in marine and urban mobility projects, while EMISIA and TNO continue to apply their knowledge in further emission and tampering analyses.

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3 Concluding remarks

As outlined above, the consortium is well-positioned to exploit its results in a variety of ways, supported by its diverse composition and strong connections across stakeholder groups, including public authorities, academia, industry, and policymakers. While the level of maturity among exploitation plans varies, from concrete actions to potential opportunities, the project has established a solid foundation for continued use and further development of its results in research, innovation, and dissemination.

The methodologies, tools, and data generated have already proven valuable for scientific analysis, regulatory application, and market-oriented initiatives. These outcomes will continue to inform advancements in emission measurement, acoustic assessment, and environmental monitoring, thereby contributing to more accurate, transparent, and harmonised approaches in future work.

Ongoing collaboration with related initiatives and participation in relevant international conferences and policy forums will sustain the project's visibility and ensure that its findings remain accessible to the wider community. Further opportunities for exploitation are expected to arise through new research projects and funding mechanisms at both national and European levels, extending the long-term impact of the project and supporting progress towards cleaner, quieter, and more sustainable mobility solutions across Europe.

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Annex: Result Ownership List

The 'result ownership list' is an updated document, based on 'Table 11: LENS results with exploitable value' from the LENS Grant Agreement (Part B, p. 27), which aims to define and enshrine the adequate protection of the project results related to the different forms of exploitable material that were predefined in the aforementioned table.

Information gathering and exchange between partners

This final document is the result of a living document that kept track of intellectual property rights, related aspects, and the ownership of results. The latter was discussed during bilateral meetings between the consortium partners indicated in the initial table, and further exchanges occurred during the project's final consortium meeting, held on 13–15 October 2025. Each of the originally listed IP information is underlined, while the jointly agreed level of ownership is indicated in bold with further explanations stated below. The decisions were made according to the rules outlined in the EU IP Helpdesk Guide (p. 11), which state that 'beneficiaries must now provide information on the owner(s) of the results (results ownership list) in the reporting. This includes whether the ownership is single or joint, the name of the owner(s), the country of establishment of the owner(s), and whether the results will be exploited by the owner(s).'

Work package 3: On-road RDE measurements of noise and exhaust emissions

The exploitable material of this work package is related to on-board vehicle testing, the demonstration of devices, and the broadening of expertise on sampling. The original aim was to protect potential intellectual property rights through scientific publications and patents where applicable.

Test procedure on-road to assess LV emissions, including PN2.5 and non-regulated pollutants
IDIADA, EMISIA, TU GRAZ, CZU, Prague, HORIBA, IFPen

Joined ownership by all initially involved partners: IDIADA, EMISIA, TU GRAZ, CZU, Prague, HORIBA, IFPen

A detailed test procedure for tests on-road based on the RDE tests for LD-vehicles but modified for the specific demands of L-Category vehicle testing was generated by TU GRAZ and verified and established by the partners EMISIA, IDIADA, IFPen, CZU and HORIBA. All procedures were documented in deliverable D3.1

PN2.5 system for on-board tests – TU Graz
Single ownership: TU Graz, Austria

A new concept for a PN counter system was developed, covering design, simulation prototyping, lab testing, and validation on a motorcycle chassis dynamometer. The system reached TRL 5, as it was successfully tested on one vehicle on a dynamometer. The concept and first validation data are published in an open-source journal (Copernicus Aerosol Research) to ensure accessibility for further

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research. For reaching TRL6 and higher, concepts are available. IP applications for sensor details are planned.

SEMS integrate with BC sensor – EMISIA

Single ownership: EMISIA, Greece

Adaptation of EMISIA ReTEMS system (measuring CO, NOx, CO_2), MAURUS sensor (measuring BCPM) and Pegasor Mini-PPC (measuring PM & PN) for on-road emissions testing of L-category vehicles. Experimental validation exercises were conducted with motorcycles on a chassis dyno using laboratory-grade equipment. This exercise ensured the accuracy and reliability of the on-road equipment.

SEMS integrate with PN2.5 system - HORIBA, TU GRAZ, EMISIA

Single ownership SEMS without PN2.5: HORIBA

The integration of the mobile PN2.5 sensor into the SEMS was not realised by HORIBA and TU Graz within the framework of the LENS project due to challenges encountered with the PN2.5 sensor under non-laboratory conditions. However, HORIBA developed a SEMS for the measurement of NOx and exhaust flow of small mopeds and motorbikes. Two additional units, without exhaust flow measurement capability, were manufactured and provided to the consortium partners.

All devices were tested on a chassis dyno at HORIBA and at TU Graz and used in on-road measurements by the TU Graz. The know-how and devices are proprietary to HORIBA. The targeted Technology Readiness Level 7 was successfully achieved within the scope of the project.

SEMS adaptations for LVs – IFPen

Single ownership, IFPen, France

Adaptation of our SEMS to be suitable for small vehicles, using a tubular structure to fix it on the footrests of the passenger. The probe inlet was also adapted to avoid dilution issues.

Mini-PEMS including PN device – CZU Prague

Single ownership mini-PEMS without PN device: HORIBA

A Mini-PEMS was developed by Horiba, employing NDIR technology for the measurement of CO, CO_2, and THC, in combination with electrochemical sensors for O_2 and NO. The device was also equipped with an exhaust flow meter, OBD interface, GPS, and weather station. An integration of a PN device was not possible within the project.

All devices were tested on a chassis dyno and used in on-road measurements. The know-how and devices are proprietary to HORIBA. The targeted Technology Readiness Level 7 was successfully achieved within the scope of the project.

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Highly compact mobile, rider-worn FTIR instrument - CZU

Single ownership: CZU, Prague, Czech Republic

Highly compact, 70x70x35 cm, 40 kg FTIR system consisting of interferometer, 5-meter path length heated optical cell, heated line, heated filter, sample pump and accessories. The system can be lifted by two large handles attached to the vehicle or to a rider-worn external frame backpack, with instrument mass resting on the passenger seat. The FTIR analyser operates with a spectral range 700 to 4500 1/cm at 0.5 1/cm spectral resolution with 5 Hz scanning rate. The time response of the instrument (t90) is below 2 seconds. The average power consumption is approximately 200 Watts at common ambient temperatures and under 300 Watts at -9 C ambient temperature. Interpretation of spectra allows for quantitative determination of concentrations of all major gaseous pollutants - greenhouse gases CO_2, CH_4 and N_2O, reactive nitrogen species NO, NO_2 and NH_3, and additional compounds such as CO and formaldehyde, with detection limit for most pollutants (excluding CO_2) on the order of 1 ppm. The system has reached TRL 6 (validation in laboratory and in relevant conditions).

On-board sound recording system – IKA

Single ownership, IKA, Germany

An on-board sound recording system was developed, covering the full process from concept design to prototyping and validation. The system reached TRL 8, as it was successfully implemented on 14 vehicles across Europe, covering all L-category vehicle classes, meaning a device demonstrator is available. The recorded data — including acoustic and dynamic parameters — are stored in open-source formats (.csv and .txt) to ensure transparency, interoperability, and long-term accessibility for further research and analysis within the project. For reaching TRL9, recommendations are available. The on-board sound recording system is documented in deliverable 3.2.

Work package 4: Revised laboratory testing and comparison with TA and on-road results

The exploitable material of work package 4 is related to the demonstrators and the topic of protocol and expertise. Intellectual property right protection was planned to be achieved through scientific papers and patents where suitable.

Database with exhaust emission data of on-road and laboratory measurements from 150+ L-category vehicles.

Ownership: TU GRAZ, IDIADA, EMISIA, CZU, IFPen

Exhaust emission data from the on-road and laboratory tests were collected by the partners TU GRAZ, IDIADA, EMISIA, CZU and IFPen. These data were aggregated, key values calculated and stored by TU GRAZ in the so-called LENsDb, a database system generated and used by TU GRAZ for exhaust gas measurement data.

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Suggested revisions to exhaust emissions TA procedure TU GRAZ, IDIADA, EMISIA, IFPen, CZU, TNO

Multiple ownership: TU GRAZ, IDIADA, EMISIA, IFPen, CZU, TNO

In order to better reflect the on-road driving of L-category vehicles in the type-approval tests, several modifications, adaptations and additions to the type-approval procedure were developed. These are documented in deliverable 4.4.

New measurement method for noise – IKA

Single ownership: IKA, Germany

A new measurement method for assessing noise emissions was developed, validated, and brought to TRL 8. The method enables standardised testing of noise-critical driving manoeuvres under realistic conditions and can be applied both on-road and on acoustic test tracks. The basis of this measurement method was, for example the driving conditions found in Deliverable 6.1, leading to high noise events. The full method is described in Deliverable 3.5. The exploitable materials include testing protocols and methodological expertise, supporting future implementation in regulatory and research contexts.

Test procedure in laboratory to assess LV emissions, including PN2.5 and non- regulated pollutants - IDIADA, EMISIA, TU GRAZ, CZU Prague, HORIBA, IFPen

Ownership: Partners IDIADA, EMISIA, TU GRAZ, CZU Prague, HORIBA, IFPen

RDE and lab tests were performed according to the capabilities of the L cat vehicles, for example, the mini-cars and mopeds were only tested on an urban trip with roads with limited maximum speed at 50km/h. The lab tests were mostly WMTC, RDC and reproduction of RDE on a roller test bed. Round-robin tests were also performed to assess the capabilities of our facilities.

A detailed test procedure for tests in laboratory, based on the type-approval tests for L-category vehicles but extended to non-regulated pollutants and on-road derived real drive cycles, was generated by TU GRAZ and verified and established by the partners EMISIA, IDIADA, IFPen and CZU.

A test procedure for verification of on-road measurement equipment in laboratory tests was generated by TU GRAZ together with HORIBA and verified and established by the partners EMISIA, IDIADA, IFPen and CZU. All procedures were documented in Deliverable 4.1

Lab device and procedure for PN2.5 - TU GRAZ, HORIBA

Single ownership: HORIBA, Germany

A laboratory device for PN2.5 measurement was developed by HORIBA, enabling the simultaneous measurement of PN10 and PN2.5. The system is based on the HORIBA MEXA-2000 SPCS series and was calibrated at HORIBA's facilities. The Technology Readiness Level (TRL) is assessed as 7, as further improvements are required to further minimise particle losses below 10 nm.

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Work package 5: Detection techniques for tampered L-category vehicles

The exploitable material of work package 5 highlights the latest solutions concerning tampering detection techniques

Database of L-category vehicle pollutant emissions measured from/at the roadside (INFO Missing)

Single ownership: IVL, Sweden

A database of L-vehicle pollutant emissions, measured from the roadside at 3 locations in Europe (Leuven (BE), Paris (FR) and Barcelona (ES)), was obtained from the in-field surveys. The database contains ab. out 1000 recordings of passing L-category vehicles, including pollutant emission idle tests in roadside inspections carried out in Leuven and Barcelona.

Database of real-life L-category vehicle sound recordings

Single ownership: KU Leuven, Belgium

A database of L-vehicle sounds, measured from the roadside at 3 locations in Europe (Leuven (BE), Paris (FR) and Barcelona (ES)) was obtained from the in-field surveys. The database contains more than 2000 recordings of passing L-category vehicles and, where available, a link to the corresponding entry/entries in the database of roadside pollutant emission measurements.

New technique and method for tampered vehicles detection - KU Leuven, TU GRAZ, TNO

Since this element does not consist of one unified result but rather several distinct contributions, the consortium has agreed to separate these techniques into individual elements, each with a designated partner responsible for its ownership, as outlined below.

On-site monitoring for tampered vehicle detection

Single ownership: TU Graz

TU Graz contributed to the on-site monitoring activities but did not participate in the development of the “New technique and method for tampered vehicles detection”.

Set of potential sound features

Single ownership: KU Leuven

KU Leuven provided a set of potential sound features for detecting tampering based on roadside noise measurements and preliminary classification algorithms. However, the available data on tampered vehicles were insufficient to develop a reliable and robust tampering detection technique.

Pollutant emission data for detecting tampering including idle test CO and HC emission measurements

Single ownership: IVL

This project has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement No 101056777

IVL supplied pollutant emission data for detecting tampering, based on roadside pollutant emission measurements combined with roadside inspections. These inspections included idle test CO and HC emission measurements and expert assessments by qualified personnel to determine whether an inspected L-category vehicle was tampered with. Nonetheless, the limited availability of data on tampered vehicles prevented the development of a reliable technique for detecting tampering through roadside pollutant emission measurements of passing vehicles.

Work package 6: Assessment and policy recommendations

The exploitable material of work package 6 includes software solutions and methods to characterise L-vehicle driving conditions and route optimisation.

Model for assessment of emission and noise benefits at global scale – EMISIA and TNO

LENS report D6.4 describes methodology for assessment of benefits of reduced emissions and noise of L-vehicles. This has been further developed in LENS based on earlier studies. Also costs and a CBA approach were defined.

TNO and HSData have developed this for noise; EMISIA has developed it for emissions.

App for route optimisation of LV mobility patterns – IFPen

Single ownership, IFPen, France

IFPen updated the model for L-category vehicles within its GECO Air app, allowing them to improve the emissions computed and give more precise results for the end user.

Set of emission factors for LVs - EMISIA, IDIADA, TU Graz, CZU Prague, IFPen

Shared ownership: EMISIA, TU GRAZ, IDIADA

EMISIA contributed to the LENS database, which enables the computation of updated emission factors. It utilised LENS measurement data and TU Graz's PHEM modelling results to produce updated emission factors for L-category vehicles in COPERT.

IFPen & IDIADA contributed to the LENS database, which allows for the computation of updated emission factors.

IDIADA contributed to the development of meaningful results and knowhow on validating the data together with providing postprocessed final values. It also contributed to the vehicle selection for representativeness of the fleet that allowed a proper final post-processing to obtain emission factors for L-category vehicles.

TU Graz generated emission maps for the PHEM vehicle emission model based on LENS measurements. Using this data within PHEM, TU Graz updated the emission factors for L-category vehicles in HBEFA 5.1.

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Table 11: LENS results with exploitable value.

WP	Description	Exploitable material	TRL (From →To)	Sectors of application	IPR Protection	IPR Owner(s)
3	PN2.5 system for on-board tests	Device demonstrator and expertise on sampling	5→7	On-board vehicle testing	Scientific article (copyright) Patents to be considered where suitable	TU GRAZ
	SEMS integrate with BC sensor		5→7			EMISIA
	SEMS integrate with PN2.5 system		5→7			HORIBA, TU GRAZ, EMISIA
	SEMS adaptations for LVs		5→7			IFPEN, IDIADA
	Mini-PEMS including PN device		5→7			CZU Prague
	On-board sound recording system		3→7			IKA
4	New measurement method for noise	Protocol & expertise	5→8		Scientific paper (copyright)	IKA
	Lab device and procedure for PN2.5	Demonstrator	6→8	Lab testing		TU GRAZ, HORIBA
	Test procedure to assess LV emissions, including PN2.5 and non- regulated pollutants	Protocol & expertise	5→8			IDIADA, EMISIA, TU GRAZ, CZU Prague, HORIBA, IFPEN
5	New technique and method for tampered vehicles detection	Technique and algorithm	3→7	Field monitoring	Patent possible & scientific paper (copyright)	KU Leuven, IVL, TU GRAZ, TNO
6	Model for assessment of emission and noise benefits at global scale	Software and method	6→8	Environmental assessment	Scientific publication (copyright)	EMISIA, TNO
	App for route optimisation of LV mobility patterns	Software (app)	6→8	Mobility optimisation	Scientific publication (copyright), protected software	IFPEN
	Set of emission factors for LVs	Dataset	6→9	Environmental assessment	Scientific publication (copyright)	EMISIA, IDIADA, TU Graz, CZU Prague, IFPEN
	Characteristic driving conditions and indicators for high noise emission of LVs	Method	6→8	Environmental assessment and field monitoring	Scientific publication (copyright)	TNO, HSData

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